Standard Practice
in
Sheet Metal Work

Manual No. 1

Gutters, Conductors
Conductor Heads

SHEET METAL CONTRACTORS' NATIONAL ASSOCIATION, INC.

A National Organization to Improve, Extend and Protect the Uses of Sheet Metal

GUTTERS, CONDUCTORS
CONDUCTOR HEADS

SHEET METAL CONTRACTORS' NATIONAL ASSOCIATION, INC.

170 DIVISION STREET • ELGIN, ILLINOIS

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170 Division St., Elgin, Illinois

FOREWORD

In 1929, the National Association of Sheet Metal Contractors (dissolved in 1933) published "Standard Practice in Sheet Metal Work," a 750 page reference book of standards of practice in fabricating and erecting sheet metal work.

Several years of exhaustive research and study, by scores of men comprising the sub-committee which prepared Sections covering particular phases of sheet metal construction, preceded the actual publication.

Much of the construction shown in Standard Practice in Sheet Metal Work was, at the time of its publication, original material — not to be found in other published literature of the industry. Many of the constructions shown had their origin in the very old craftsmanship brought to this country by the sheet metal artisans who came to America in the last century.

To this basic heritage was added the new materials and new techniques of the first quarter of the twentieth century.

The men who prepared Standard Practice in Sheet Metal Work created even beyond their vision. While the industry has advanced notably in the years since publication of this book, basically most of the constructions shown in Standard Practice in Sheet Metal Work are, today, as applicable as they were in 1929.

Standard Practice in Sheet Metal Work was widely distributed among the architects of the 1930's. But in the 1930's, through a series of circumstances, plates, unbound pages, drawings, manuscripts passed out of existence.

Today, despite the greatly enlarged literature of the industry, there is a growing demand for copies of Standard Practice in Sheet Metal Work. To meet this demand, the Architectural Sheet Metal Standards Committee of the Sheet Metal Contractors' National Association, Inc., has undertaken the publication of a series of Manuals to replace the former book. Each Manual will deal with one of the major phases of present day sheet metal construction.

These Manuals make use of a large part of the text and drawings from Standard Practice in Sheet Metal Work. Where necessary, original text and drawings will be supplemented by information which accommodates the new materials and new techniques which have become acceptable since 1929.

The Sheet Metal Contractors' National Association has been given permission to use material from Standard Practice in Sheet Metal Work by the heirs of the estate of George Harms, the General Chairman of the Trade Development Committee of the former association. This permission is sincerely appreciated.

SHEET METAL CONTRACTORS' NATIONAL ASSOCIATION, INC.
Architectural Sheet Metal Standards Committee

ACKNOWLEDGMENT

This Manual of construction for sheet metal work is made possible only because of the foresight and immeasurable labors of the members and section chairmen of the Trade Development Committee of the former National Association of Sheet Metal Contractors and the guiding spirit of these farsighted committeemen—the General Chairman—George Harms of Peoria, Illinois.

Through his untiring efforts, Standard Practice in Sheet Metal Work developed from a dream of the industry into a reference guide of proper construction for sheet metal contractors and the architects and engineers who design and specify sheet metal work.

Through his willingness to contribute financially, far beyond his just share, Standard Practice in Sheet Metal Work was printed and is recognized as one of the monumental books of the construction industry.

So that these services which George Harms gave so generously to this industry may be for all time perpetuated in the minds of his fellow sheet metal contractors and those who buy our services, the Sheet Metal Contractors' National Association, Inc., hereby dedicates this Manual to the memory of the man who wrought so well to establish the sheet metal industry on a high plane —

GEORGE HARMS

1860—1945

CONTENTS

Introduction

Roofing, Gutters, Conductors

Section I

The roof is the most important part of a building as it protects from the elements, not only all other parts of the structure, but the contents and occupants as well.

Frequently the owner has but a hazy idea of the merits of the various types of roofing and he depends on the architect to recommend the best material available for the purpose.

The practice of trying to effect a saving by reducing roofing costs, when the total estimates submitted for a building exceed the amount appropriated, or available, has been proven wasteful and expensive in the end. The architect or general contractor who persists in this practice is not serving the best interests of his clients.

In some types of buildings the roof is an important part of the architectural design and it is not difficult to decide what type of roofing is best suited for the construction.

Whether tin, slate or tile is selected for the roof of a residence, school or public building, careful consideration should be given to the quality of the material and the selection should be made of a material which has proven itself for durability as well as for its adaptability to the particular type of architecture.

It is equally important to give careful consideration to the selection of roofing material for factories, warehouses and other similar buildings as in many cases expensive machinery and equipment, as well as valuable merchandise, must be protected against damage.

The methods illustrated and described in this section should be followed to obtain the type of roof which will give many years of satisfactory service at the lowest cost per year of such service.

Roofing, Gutters, Conductors

Section I

Molded Sheet Metal Conductor Heads

Drawing No. 1

The elevations of nine types of sheet metal conductor heads for square, round or rectangular conductors, are presented in Drawing No. 1. The method of erecting them in practical work is shown on the following drawings.

There is no limit to the designs that may be used in conductor head construction. While those shown have right angular corners in plan, heads may be constructed in round, octagon and beveled outlines, when viewed in plan.

Plain types are shown in Fig. 1 to 3, inclusive, while more elaborate designs are indicated in Fig. 4 to 9, inclusive.

In making use of conductor heads two methods are employed. In one case the gutter outlet discharges into the head and the conductor is connected to the bottom of the head; in the other case the gutter outlet is connected directly to the conductor and a false head is used for ornamental purposes only.

In all cases where water is discharged into conductor heads, screens are used to cover the top to prevent birds building nests in the heads; when false heads are used, sheet metal covers are employed.

Conductor Fasteners and Ornamental Bands

Drawing No. 2

Drawing No. 2 shows the details for conductor fasteners and ornamental sheet metal bands for either round or square conductors or leaders.

In the upper plan in Fig. 1 is shown the construction of a wrought metal conductor fastener made from $1/8 \times 1$ in. material. An elevation of the ornamental bands is shown, there being no limit to the designs in which they may be produced in sheet metal. The plan of the ornamental bands is presented below. Fig. 2 shows the plan and elevation of a fastener and ornamental band for a round conductor, and Fig. 3 presents a plan and elevation of fastener and ornamental band for a square conductor. In this construction, a malleable iron hook or fastener is used, the conductor being secured with twisted wire, as shown: This style of fasteners can also be obtained for round conductor. If desired to omit the ornamental band, fasteners may be hinged in either round or square shapes.

Roof Connections to Conductor Heads

Drawing No. 3

Two types of roof connections are given in are employed.

Fig. 1 shows a flat roof connected to an outlet tube, which in turn is connected to a conductor head, the head connected to the conductor or leader. This leader is secured to the wall with a conductor fastener over which the ornamental sheet metal band is placed. Note that the outlet tube is protected from leaves and rubbish entering the tube by a hinged strainer.

In Fig. 2 is presented another type of connection from a hanging gutter on a pitched slate roof to a gooseneck which is connected to the conductor head. The conductor head is connected to the conductor as shown.

Another method may be employed whereby the gooseneck is connected to the conductor with a false head serving as an ornament only.

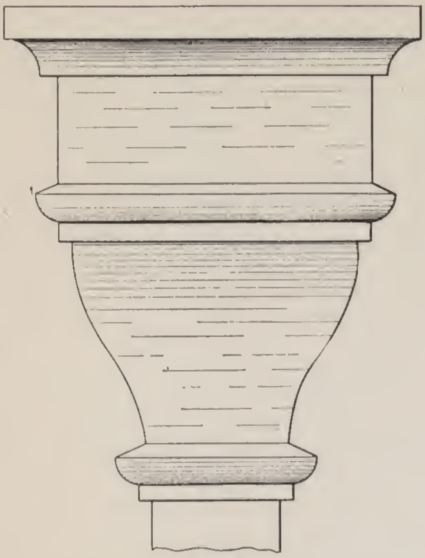


FIG. 1

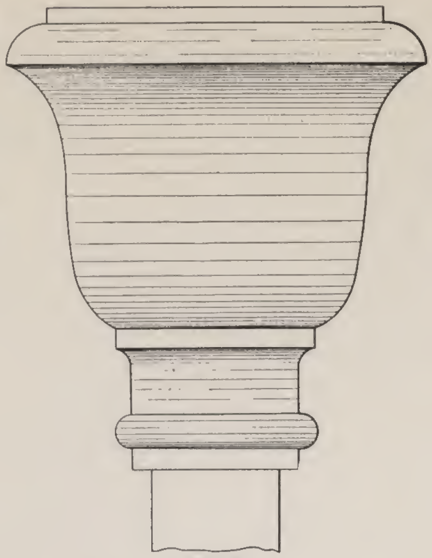


FIG. 2

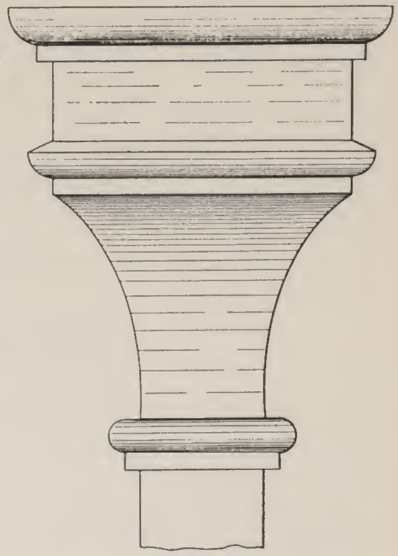


FIG. 3

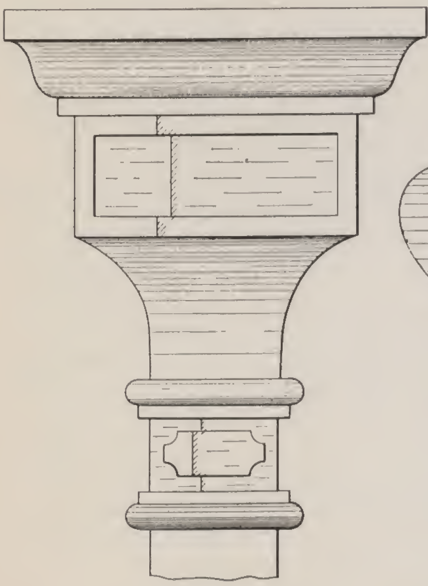


FIG. 4

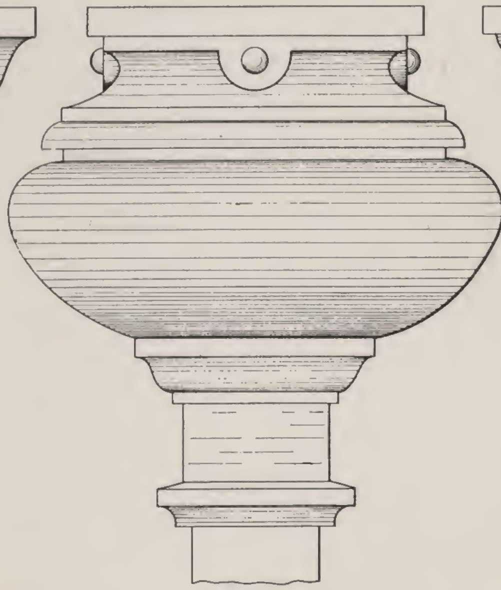


FIG. 5

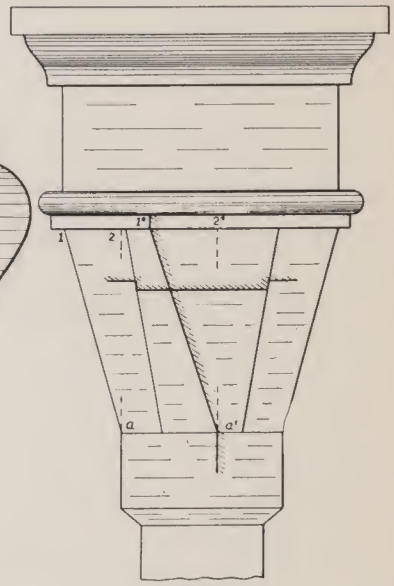


FIG. 6

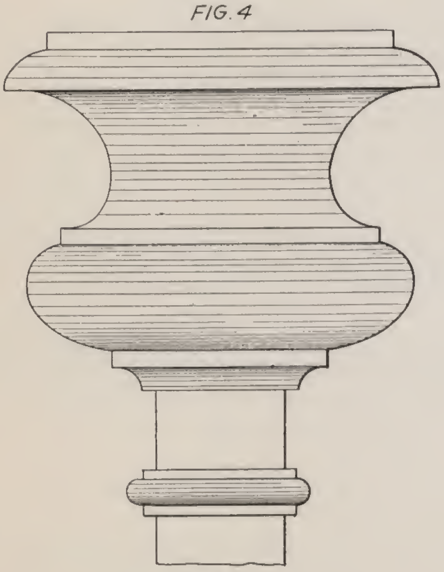


FIG. 7

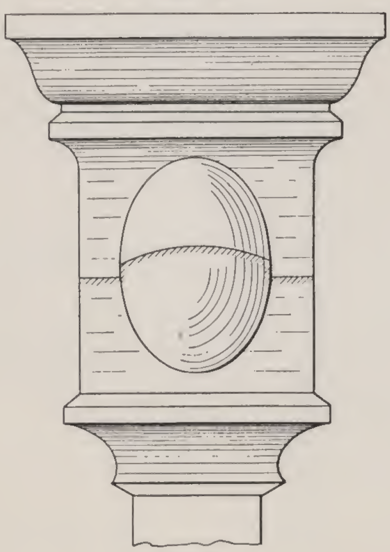


FIG. 8

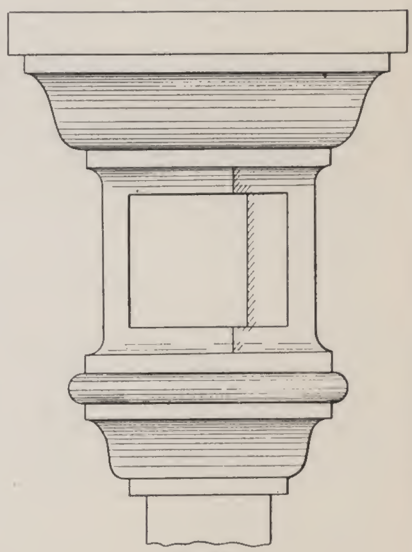


FIG. 9

—SCALE 2" = 1'-0"—

DRAWING NUMBER 1

MOLDED SHEET METAL CONDUCTOR HEADS

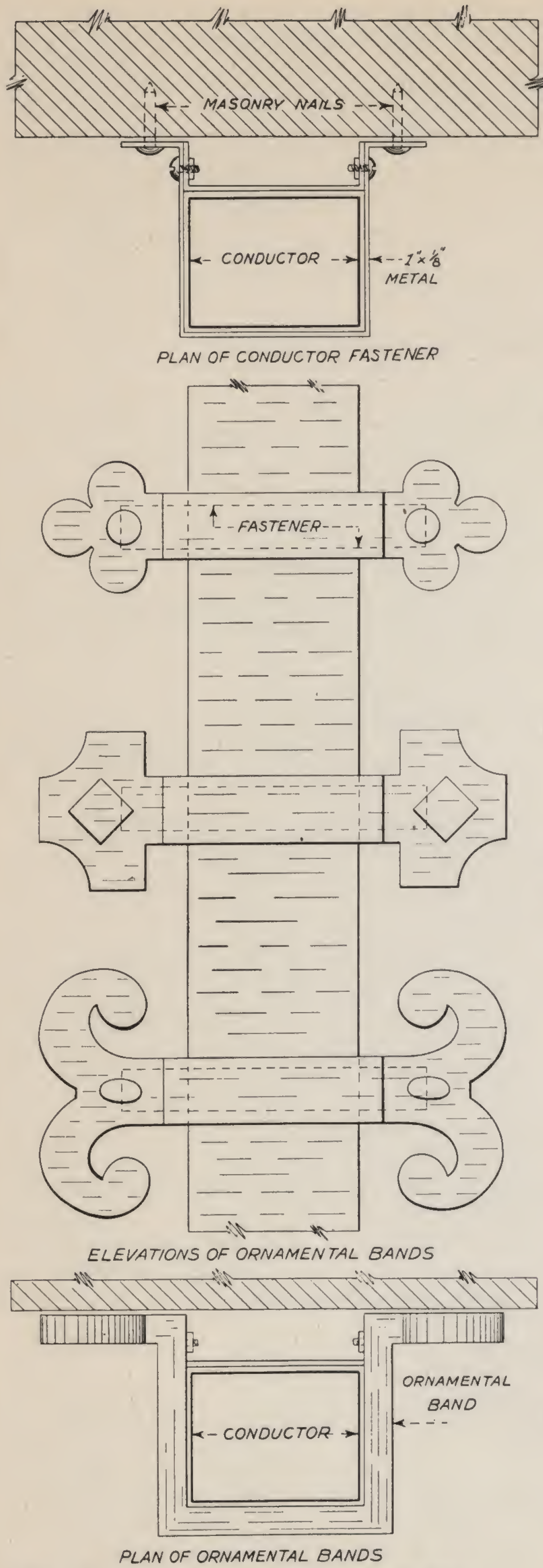


FIG. 1 PLANS AND ELEVATIONS OF WROUGHT METAL CONDUCTOR FASTENER & SHEET METAL BANDS FOR SQUARE CONDUCTORS

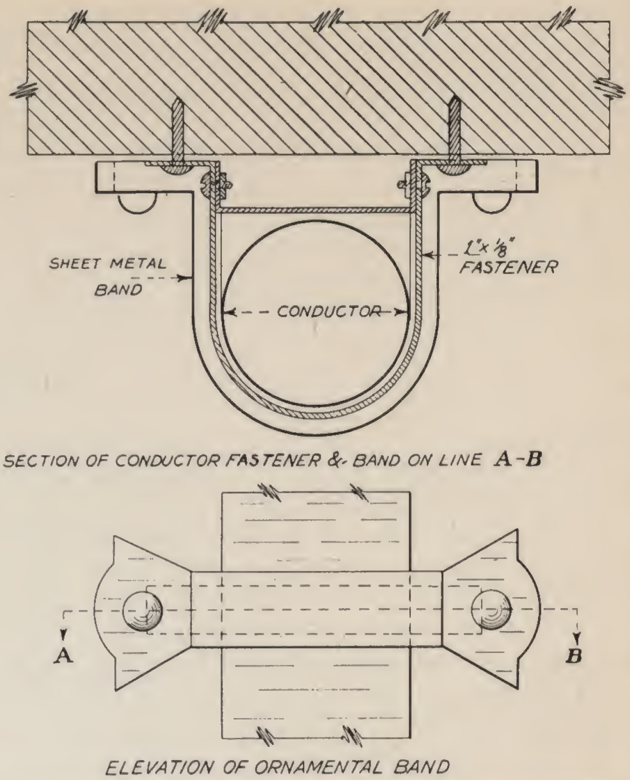


FIG. 2 SECTION AND ELEVATION OF WROUGHT METAL CONDUCTOR FASTENER & SHEET METAL BAND FOR ROUND CONDUCTOR

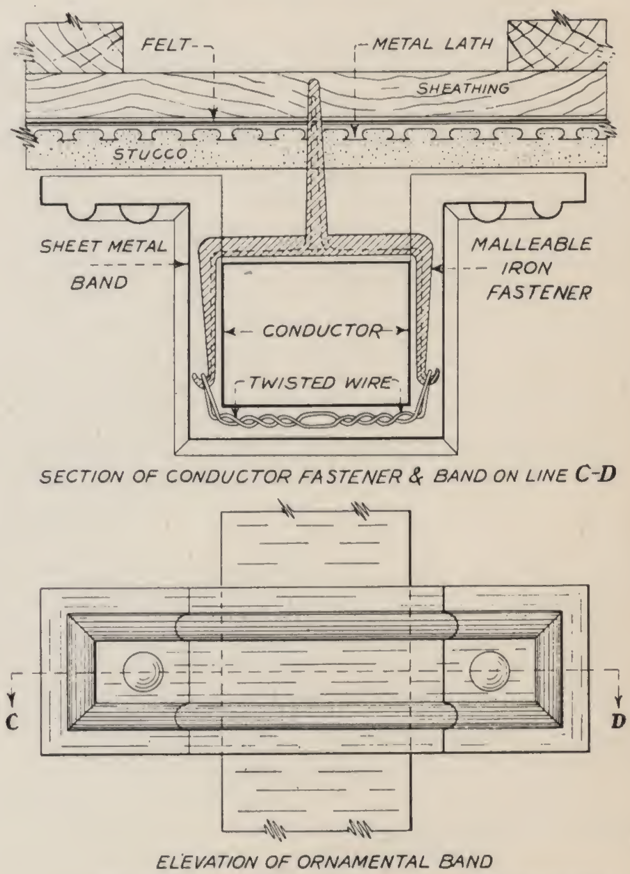


FIG. 3 SECTION AND ELEVATION OF MALLEABLE IRON CONDUCTOR FASTENER & SHEET METAL BAND FOR SQUARE CONDUCTOR

— SCALE 3"=1'-0" —

DRAWING NUMBER 2 CONDUCTOR FASTENERS AND ORNAMENTAL BANDS

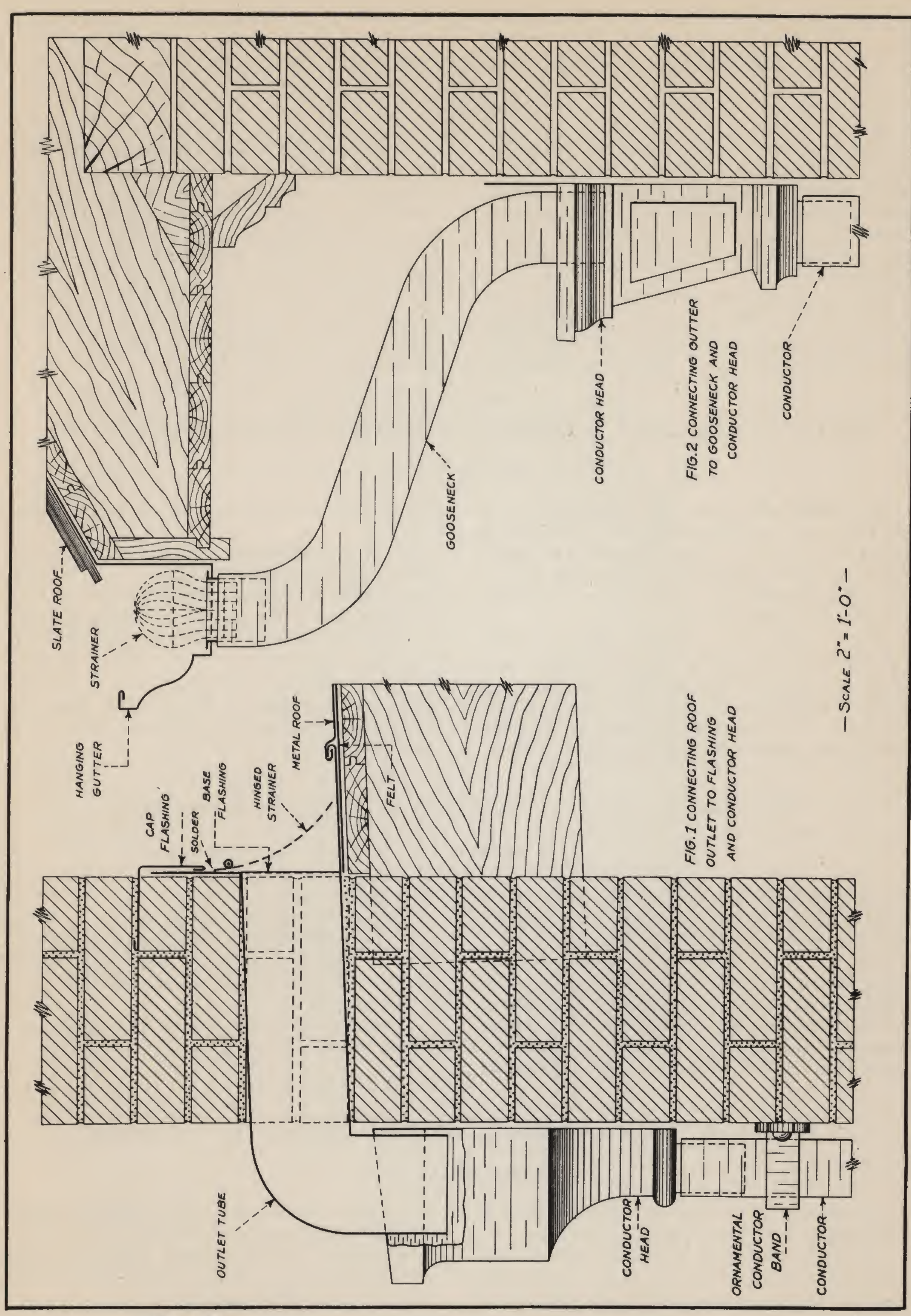


FIG.2 CONNECTING GUTTER TO GOOSENECK AND CONDUCTOR HEAD

FIG.1 CONNECTING ROOF OUTLET TO FLASHING AND CONDUCTOR HEAD

DRAWING NUMBER 3

ROOF CONNECTIONS TO CONDUCTOR HEADS

Overflow, Outlet Tube and Conductor Head

Drawing No. 4

When a gutter is formed between a parapet wall and a pitched roof, as shown in the detail in Drawing No. 4, provision is made for overflow tubes at intervals along the wall to prevent the water from backing over the flashing of the gutter lining, in case of stoppage or freezing of conductor.

Note in the drawing that the gutter flashing and the lock to which the standing seam roofing is connected is not less than 3 in. above the upper line of the overflow tube. The overflow projects about 2 in. over the outside wall with a downward flange which acts as a drip.

To prevent seepage of water through the wall in case of an overflow, the overflow tube is flashed all around on the outside as indicated. The outlet tube is connected to the gutter lining in the usual manner with a hinged strainer as shown. The conductor band and conductor are shown with a 1-in. projection from the wall. Conductor fasteners of the type shown in Drawing No. 2 are used.

Outlet Tube and Overflow Connection Through Gargoyle

Drawing No. 5

The method of making roof connections when the outlet and overflow tubes are combined in one in the form of a Y and pass through a sheet metal gargoyle is presented in Drawing No. 5. The connection to the metal flashing and conductor head is also shown.

As the height of the parapet wall above the roof line is not over 18 in., the base flashing is put on in one piece, locked to the projecting edge which is caulked in the top of the stone coping, as shown. This lock provides for expansion and contraction, particularly when copper is used. The one-third full size detail of this lock is shown in Fig. 2.

Attention is directed to the construction of the outlet tube and overflow in Fig. 1. A water-stop is placed where indicated on the drawing, so that in case of heavy rain, the water rushing through the outlet tube will not overflow through the overflow tube while the conductor is open. If, however, the conductor is frozen shut in the winter, when the ice begins to thaw on the roof, the water then overflows through the mouth of the gargoyle.

Conductor, Head and Bands—Typical Erection

Drawing No. 6

The sectional view and partial elevation in Drawing No. 6 show a conductor erection from the eaves gutter to the sewer drain.

The roof in this case is covered with standing seam roofing connected to a half-round gutter. By means of a gooseneck the gutter is connected to the conductor head, which leads into a square conductor, secured with conductor hangers 1 in. away from the wall and covered with ornamental sheet metal bands.

Where the conductor may be subject to abuse, it is recommended that cast iron sewer connections or cast iron shoes be used as indicated, whether connecting to the sewer drain or leading to the ground.

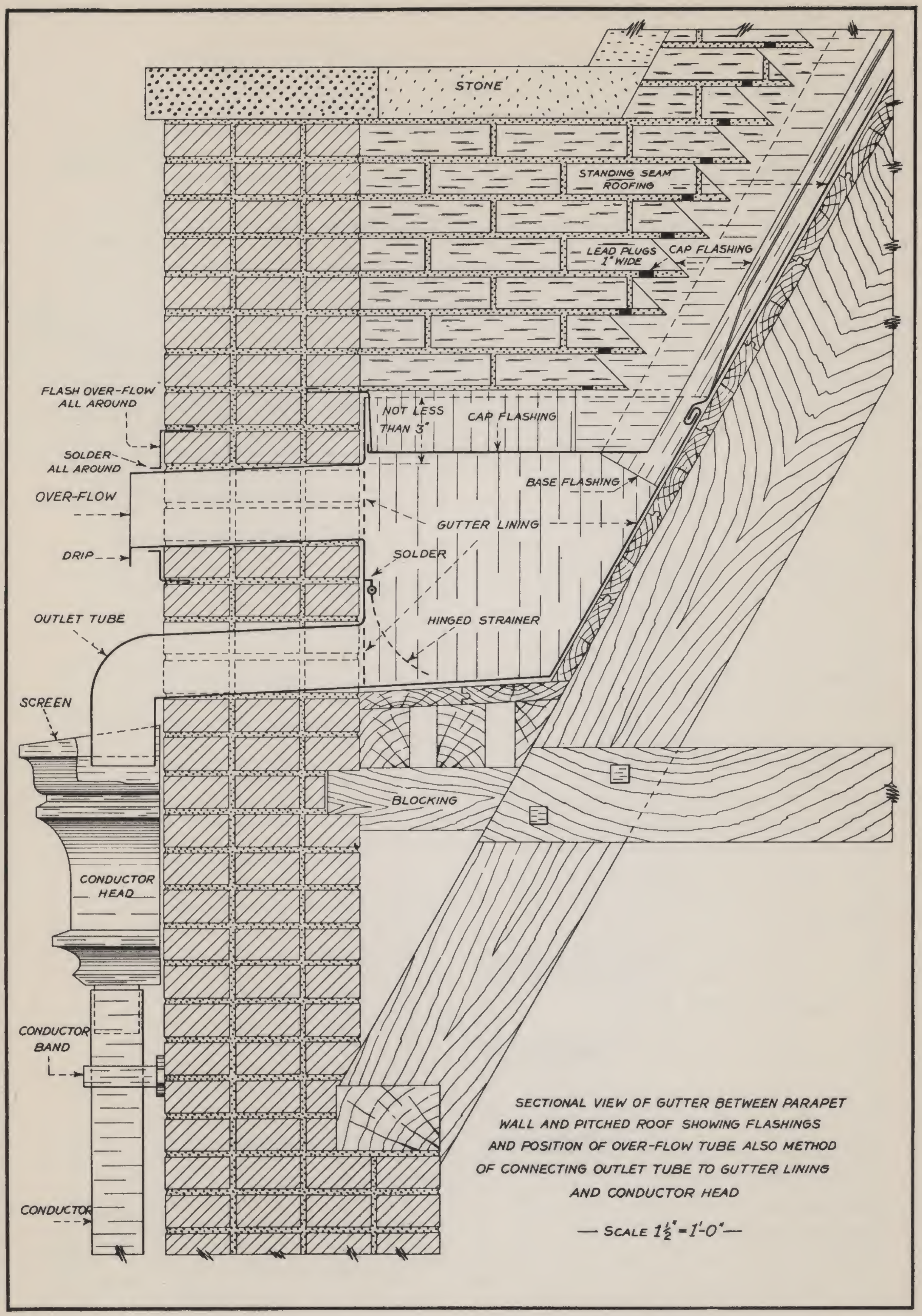
A sloping screen top is to be used on the conductor head.

Fourteen Styles of Roof Gutters and Eaves Trough

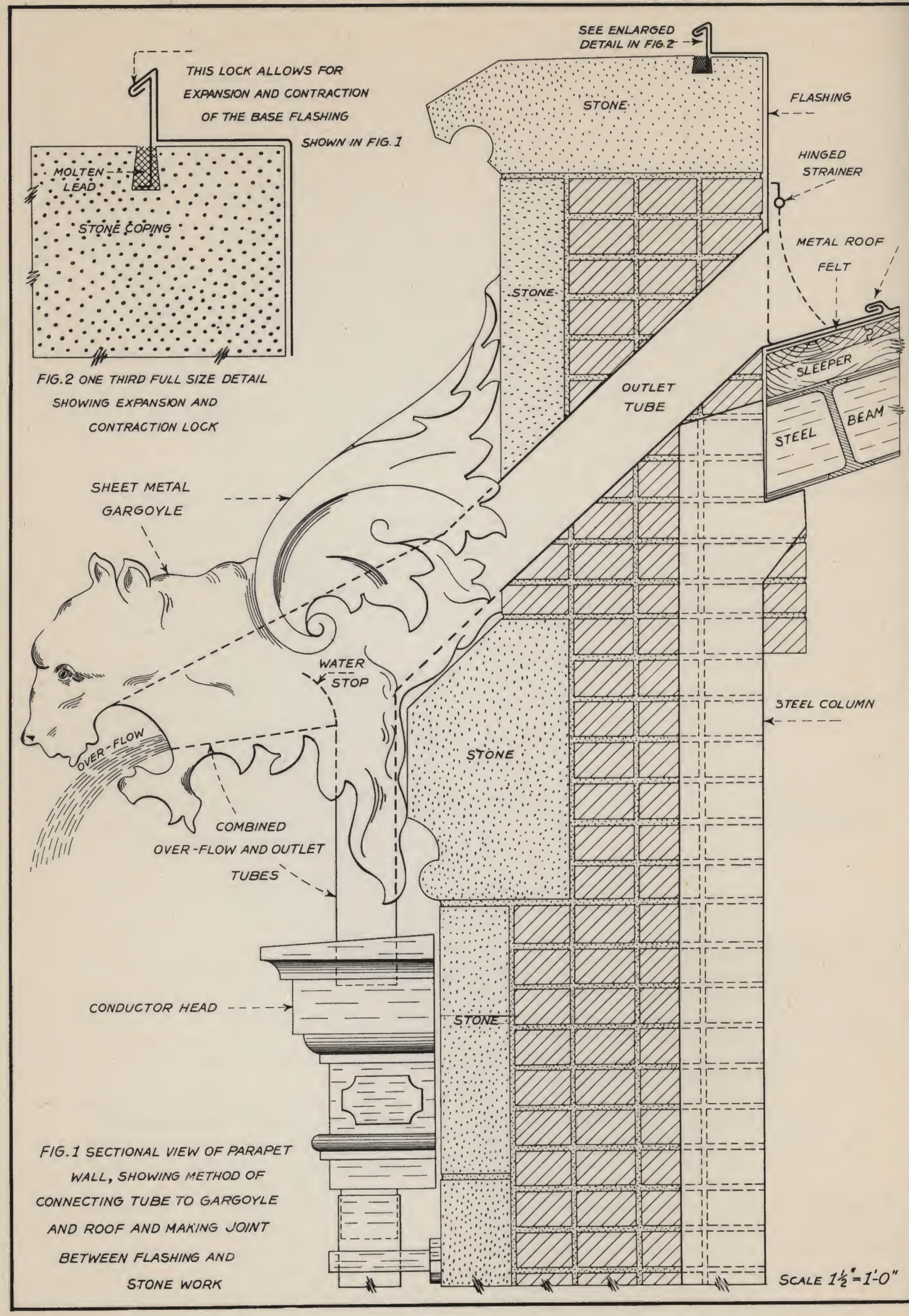
Drawing No. 7

In Drawing No. 7 fourteen different types of roof gutters and eaves troughs are shown.

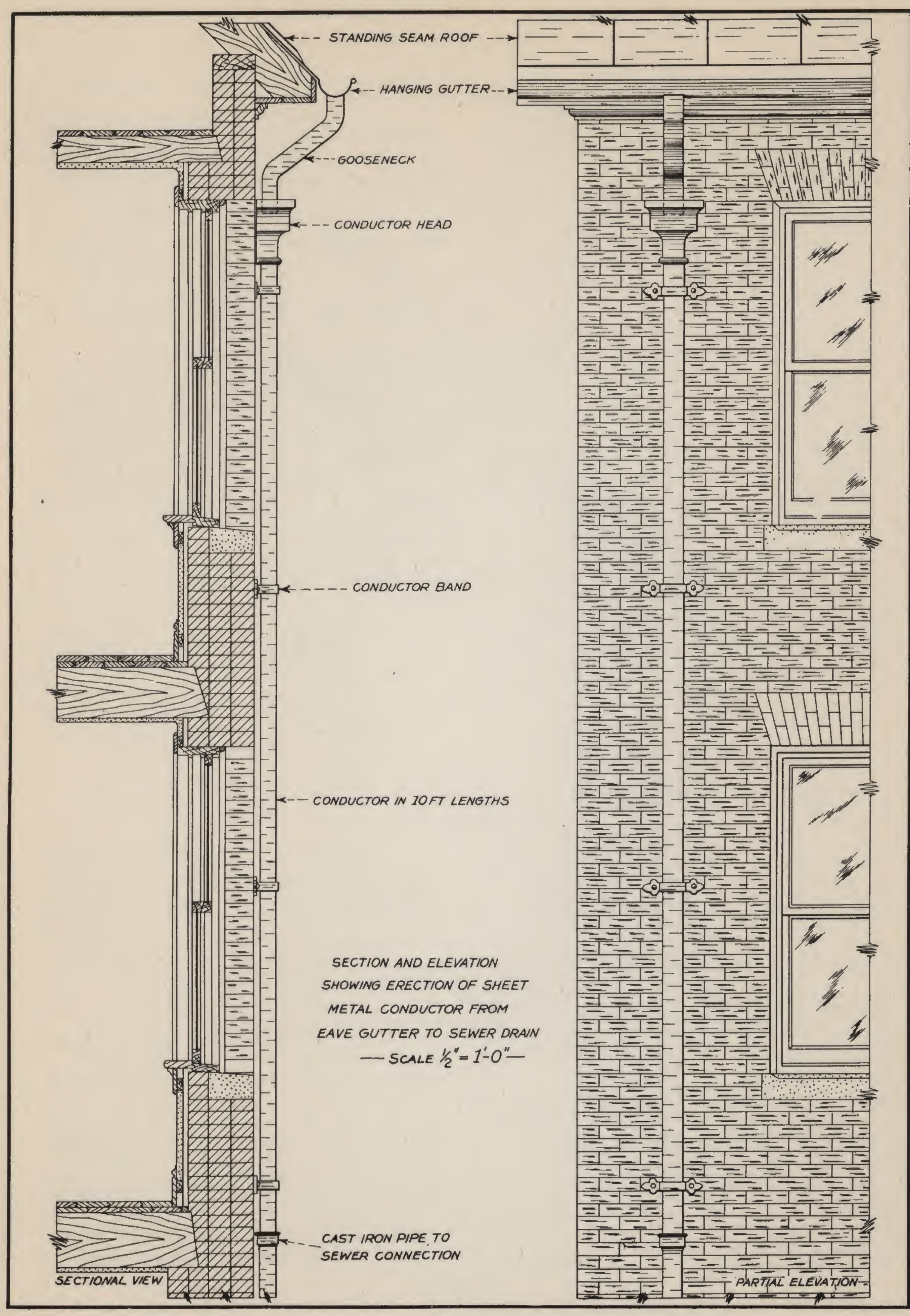
The styles marked *A*, *A-A* and *B* are for use on pitched roofs and are sometimes called stop gutters. Several courses of shingles, slate or tile are applied before these gutters with the proper pitch to outlets, are installed. Braces are fastened to the gutter bead and nailed to the sheathing and spaced 30 in. on centers. The roofing is then applied in the usual manner.



Drawing Number 4 OVERFLOW, OUTLET TUBE AND CONDUCTOR HEAD

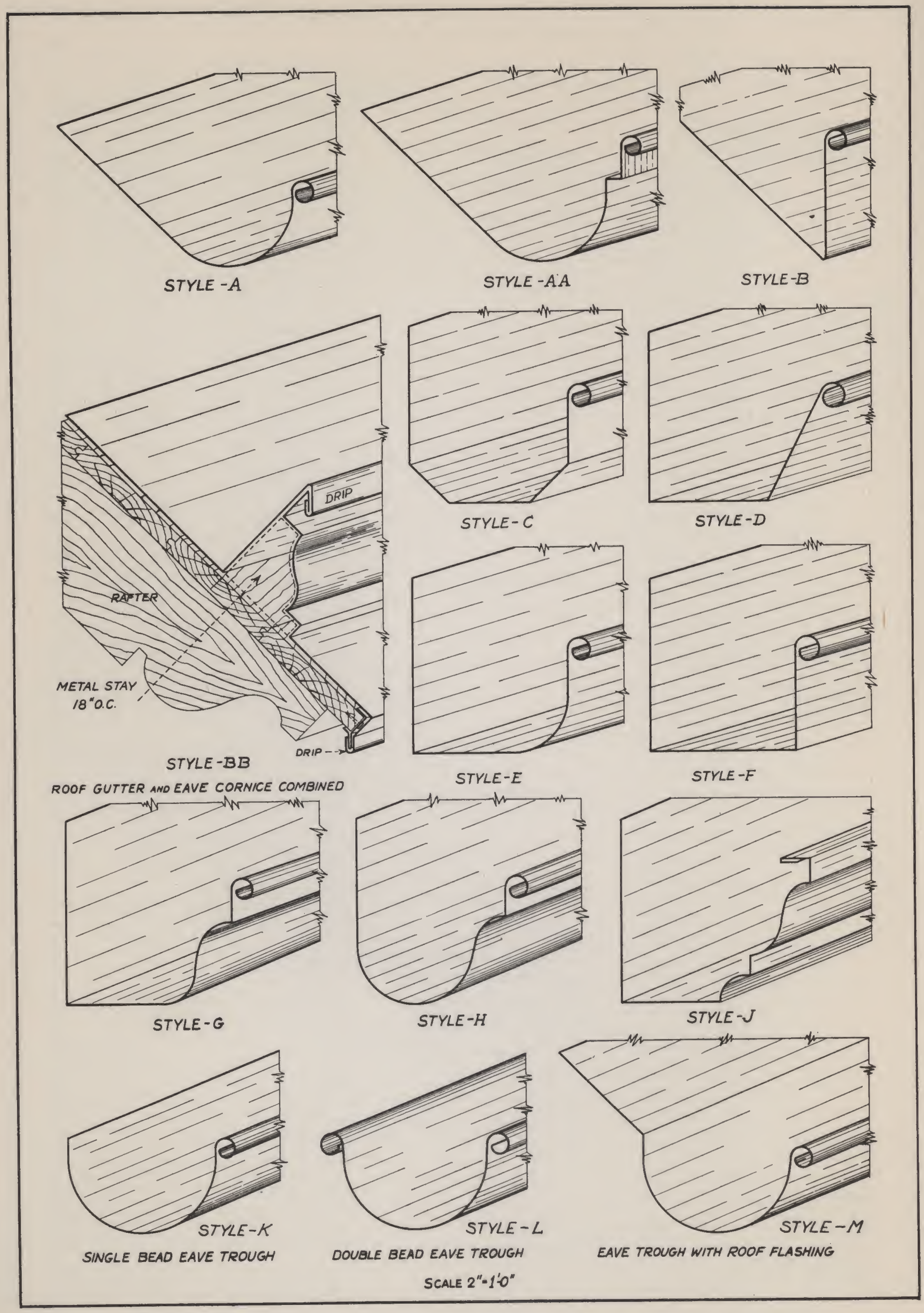


Drawing Number 5 OUTLET TUBE AND OVERFLOW CONNECTION THROUGH GARGOYLE



DRAWING NUMBER 6

CONDUCTOR, HEAD AND BANDS - TYPICAL ERECTION



DRAWING NUMBER 7 ROOF GUTTERS AND EAVES TROUGH

A combination roof gutter and eaves cornice is shown in that marked *B-B*. With this type the eaves strip is first applied to the edge of sheathing, the cornice locked to this as shown, the metal or wood stays spaced 18 in. on centers. The edge of the gutter is turned at the front and hooked and locked to the edge of the cornice. Provision for the proper pitch to the outlet is important.

Styles *C* to *K* are standard types of hanging gutter. With these $\frac{1}{8}$ x 1-in. band iron hangers are used, formed to the shape of the gutter, spaced 30 in. on centers and nailed to the facia of the cornice with proper pitch to outlets. Band iron braces are attached and applied to the roof in the same manner as for *A* and *B*.

Style *L* has a double bead and is hung below the eaves with special hangers. Style *M* has an apron extending up the roof and can be shingled over or the upper edge locked to the sheet metal roof. Roof braces are the same as for Styles *A* and *B*.

Roof Gutters for Slate or Flat Tile Roofs

Drawing No. 8

In Drawing No. 8 two types of roof gutters for slate or flat tile roofs are presented.

The general construction of the type marked Fig. 1 is the same as for the standard roof gutter shown in Drawing No. 7. This gutter is designed for heavy duty where large gutters are required and also to withstand the weight of snow and ice. The slotted hole in the angle iron allows for expansion and contraction of the metal. On this gutter the edge is turned at the top and cleated to the roof. Provision for proper pitch to the outlets is made.

Fig. 2 is a roof gutter and cornice combined. The wood construction is as shown on the drawing, the board for the bottom of the gutter having the proper pitch to outlet. The front or cornice is applied as shown or an eaves strip as shown on Drawing No. 7, Style *B-B* may be used. The gutter is formed the same shape as the woodwork; the front edge at *C* is single or double seamed. A cant strip is placed on the roof and the gutter constructed over it. The gutter is then nailed to the roof sheathing above the cant strip. Felt used under slate or tile roofing laps over the sheet metal gutter in all cases.

Roof Gutter for Concrete Tile Roof

Drawing No. 9

The method of connecting a roof gutter to concrete tile roof and also the correct method of connections between the gutter and conductor, are presented in Drawing No. 9.

As shown in Fig. 1, the gutter is formed with a bead or with angle iron as shown in Fig. 1, Drawing No. 8. In place of top braces and nails through the tile, $1\frac{1}{2}$ x $\frac{1}{4}$ band iron braces are used under the gutter, formed to the proper shape. These are laid over the second course of tile, 30 in. on centers, and secured to wood sleeper, as shown.

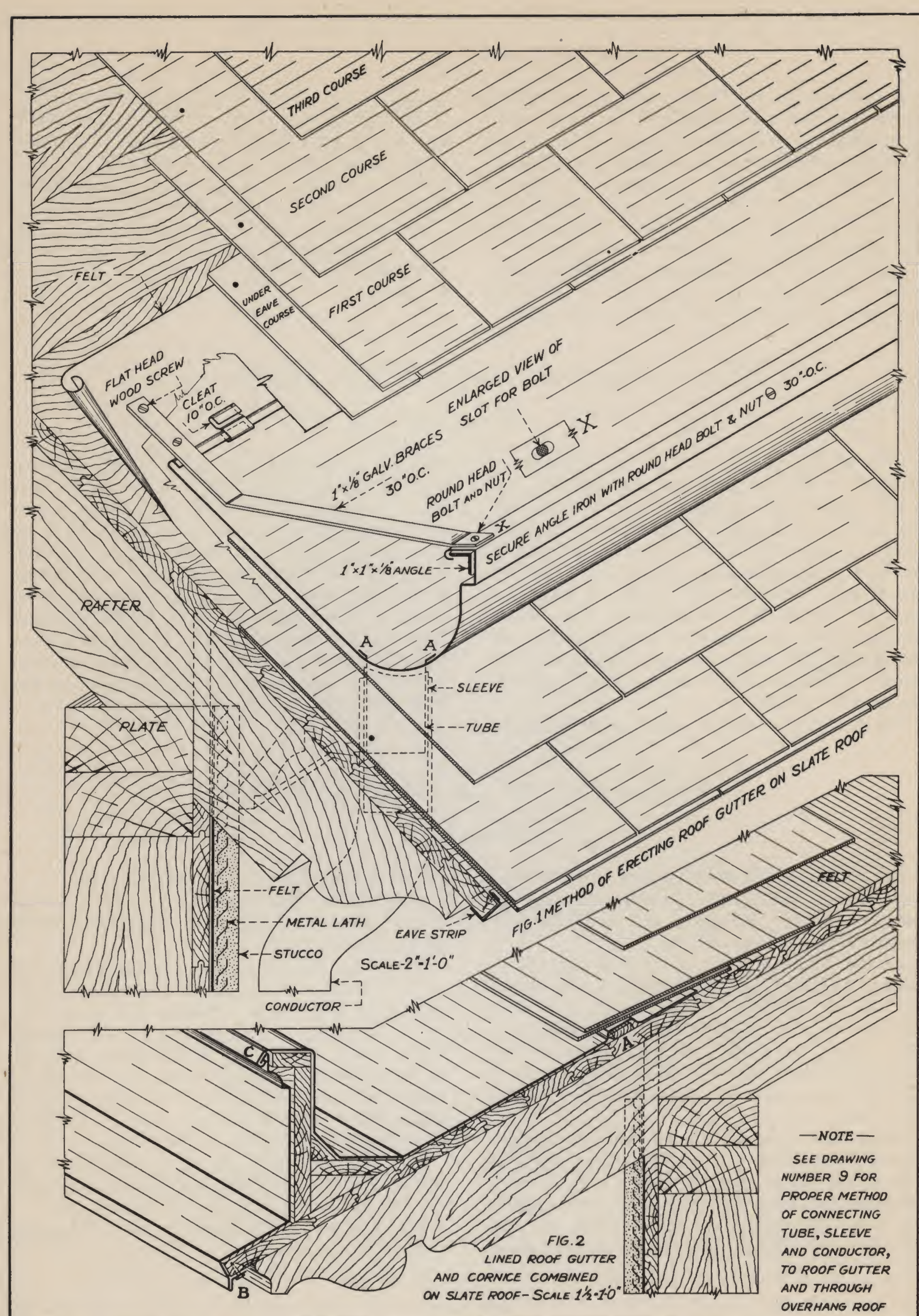
Braces are carefully lined to give the proper pitch of the gutter to the outlet. The gutter is laid on the braces, the top having a $\frac{1}{2}$-in. edge turned is secured to the wood sleeper by continuous cleat. No nails are driven through the gutter, thus providing for expansion and contraction. All cross seams are riveted and soldered.

A band iron cleat is formed to match the bead of the gutter and is riveted or bolted through the gutter at each brace.

The flange and sleeve are shown in Fig. 2 and 3. The size of the flange is four times the diameter of the sleeve. The sleeve fits into the flange, cut to the pitch of the roof and properly lapped and soldered. The length of the sleeve is shown at X, the sleeve inserted in the conductor not less than 2 in. The flange is laid on the second course of tile under the gutter as shown at *A*. The tube slips into the sleeve not less than 2 in.

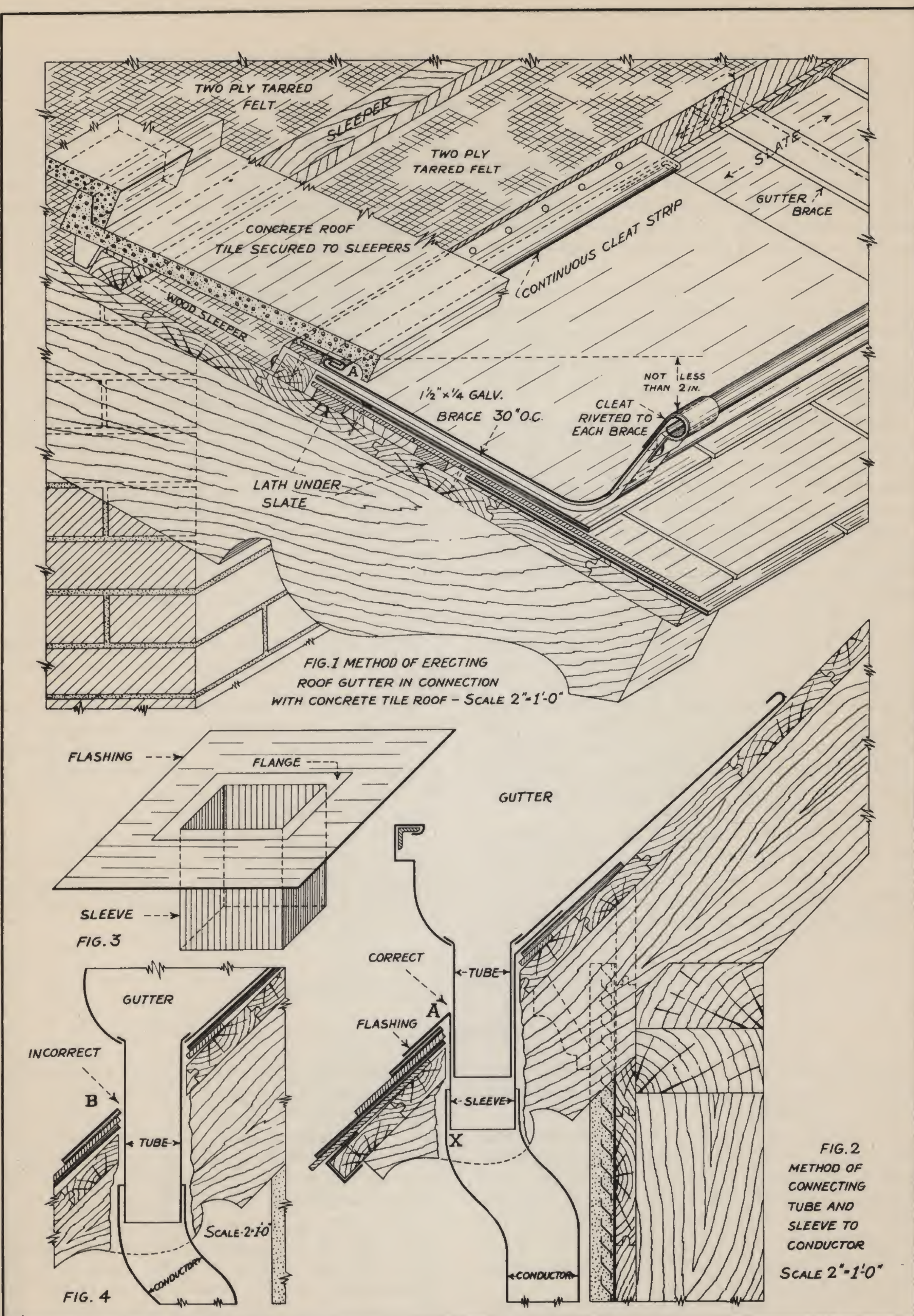
The construction of the flange and sleeve in this manner prevents streaking the walls and conductors should the tube become disconnected.

Fig. 4 shows the incorrect procedure, but is one frequently employed.



DRAWING NUMBER 8

ROOF GUTTERS FOR SLATE OR FLAT TILE ROOFS



DRAWING NUMBER 9 ROOF GUTTER FOR CONCRETE TILE ROOF

Gutters for Tile Roof—Concrete Construction

Drawing No. 10

Drawing No. 10 shows another type of roof gutter laid in concrete construction in connection with Spanish tile roofing and sheet metal cornice. The method of lining roof gutters in fireproof, concrete construction and at the same time allowing for expansion and contraction of the metal, is given below.

While the roof is being filled with cinder concrete, beveled sleepers are laid parallel to the slope of the roof, about 24 in. apart, in the shape similar to Diagram *S* at left of Fig. 1. The gutter shown is graded to the roof outlets with concrete or wood blocking.

As the gutter is large in girth, allowance is made for free movement of the metal by the use of a cap flashing at the eaves. Care is required when bending the upper part of the cap flashing as at *P*, to have it pitch to the front.

When sheathing the gutter, the upper edge of the front of the gutter must be at least 2 in. below the bottom of the cap flashing to prevent leakage.

Over the top closure tile a cap flashing is set, first bending the top in position as shown at the right at *A*. The upper edge is secured by cleats spaced 10 in. apart. To this projecting edge, the gutter lining is locked as at *B*, then turned down with the mallet, loosely, as at *C*. Cleats, indicated by *X*, are nailed 10 in. apart and over the cleats the cap flashing is laid and the projecting ½-in. edge of the cleat turned over as shown at *Y*, to hold down the flange.

The outlets are connected to the inside cast iron drain pipes, by means of heavy sheet lead tubes. Brass ferrules are soldered to the lead tubes and caulked into the cast iron drain by the plumber.

When the run of the gutter is long, expansion joints are placed at the high points of the gutter, following the constructions shown in Fig. 2 to 4, inclusive. Fig. 2 shows how the heads are flanged and soldered to the ends of the gutter. The left head is indicated by 1, 2, 3, 4 and 5, and the right head by 1′, 2′, 3′, 4′ and 5′. These two heads have flanges turned outward, as shown. They are high enough above 5 and 5′ to permit the sliding cap to slip in place easily. As the head extends below the bottom line of the cap flashing and as the sliding cap slips up behind the cap flashing, as shown, allowance is made for a flange which acts as a lock, above the bends at *a* and *a*. This short flange is soldered to the back of the gutter lining from *a* to *b* on both ends. The sliding cap is made as shown in Fig. 3 and 4.

Fig. 3 shows the upper end of the sliding cap. Note that it slips over the flanges bent on the heads and also locks in the lock edges *a-b* shown in Fig. 2, as indicated in Fig. 3. When bending the lock on the sliding cap, a piece of band iron about ⅛ in. thick is placed in each lock at *d-e* and then *d-e* is bent to the proper angle. This prevents the lock from closing. The band iron should be oiled before insertion to facilitate its easy removal.

The method of construction at the bottom of the sliding cap is shown in Fig. 4, where the lower end is shown broken. Note that the turned edges of the cap lock in the projecting flanges of the heads and a vertical flange *i* turns down to cover the cap flashing at *C* in Fig. 1.

After the heads are soldered in position, the gutter is set, the distance *O* between the heads in Fig. 2 being determined by the temperature at the time of erection and the length of gutter for which expansion must be allowed.

Eaves Gutters at Flat Roofs

Drawing No. 11

In Drawing No. 11 four different types of eaves gutters connecting to flat seam and composition roofs, are presented.

A typical eaves gutter with reinforced bead for flat seam roofing is shown in Fig. 1, the bottom of the gutter resting on projecting brick corbels. An angle edged drip strip is soldered to the bottom of the gutter to prevent seepage of water through the brick wall in case of an overflow. The edge is turned at top of the gutter and cleated to the sheathing.

The roofing material is locked in the usual manner. Band iron braces are bolted to the top edge of the gutter and secured to the roof with two barbed wire nails. The braces are capped with sheet metal and soldered to prevent leakage. To avoid water following the brace and dripping over the front edge of the gutter, braces are twisted as shown, and spaced 30 in. on centers.

The front edge of the gutter is lower than the eaves line of the roof to avoid water backing up on the roof. When the gutter connects to an inside drain, the tube is carried through the full thickness of the wall with a brass ferrule for

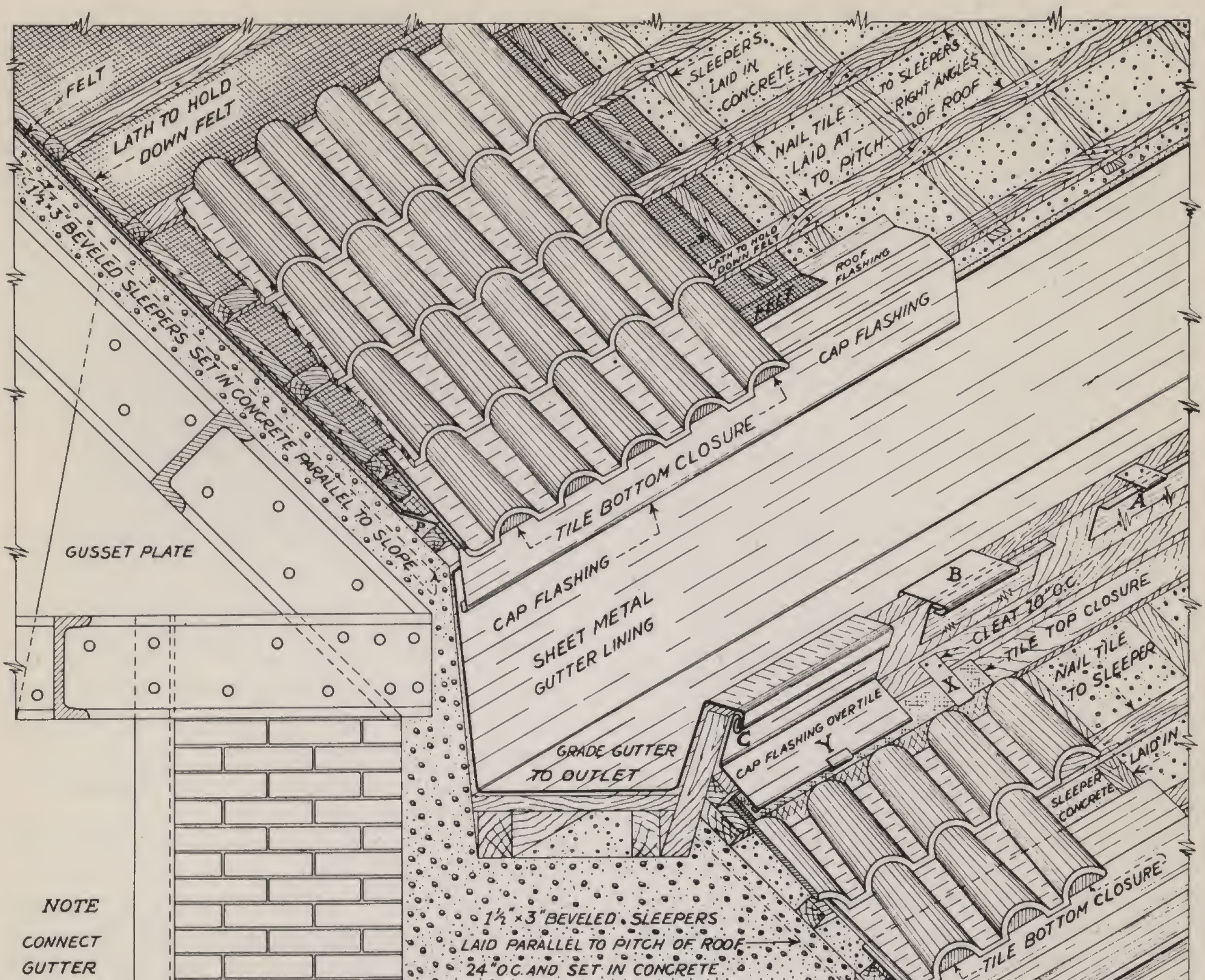


FIG. 1 METHOD OF CONSTRUCTING ROOF GUTTER ON A CONCRETE BASE IN CONNECTION WITH A SPANISH TILE ROOF AND SHEET METAL CORNICE

FIG. 3

FIG. 2 CONSTRUCTION OF EXPANSION JOINT

SCALE ¾"=1'-0"

DRAWING NUMBER 10

GUTTERS FOR TILE ROOF -- CONCRETE CONSTRUCTION

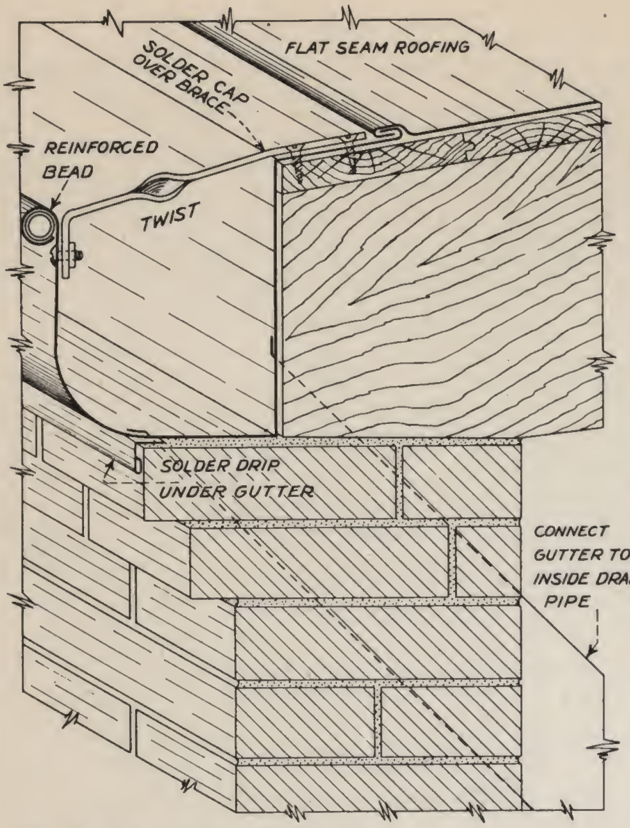


FIG. 1 EAVE GUTTER ON BRICK WALL CONNECTING TO FLAT SEAM ROOFING

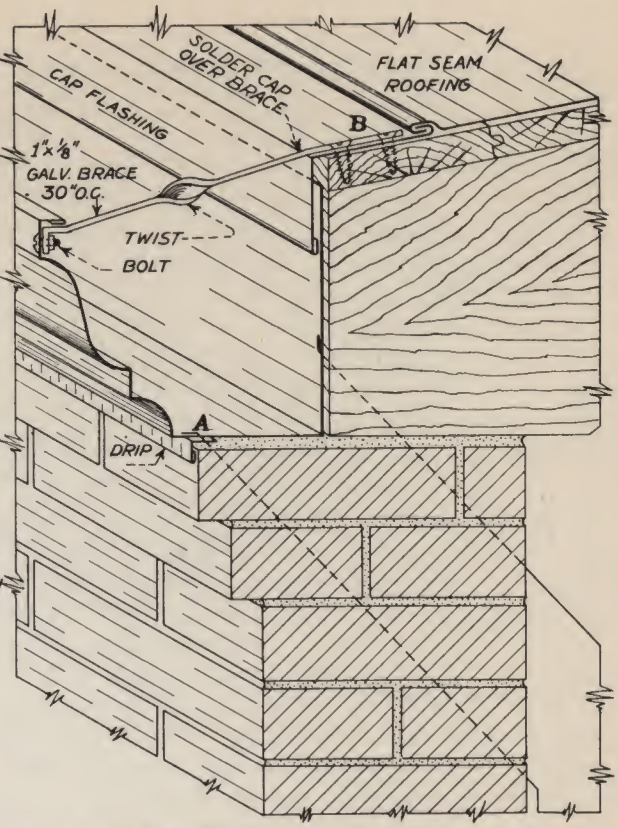


FIG. 2 ANOTHER TYPE OF EAVE GUTTER ON BRICK WALL WITH CAP FLASHING CONNECTING TO FLAT SEAM ROOFING

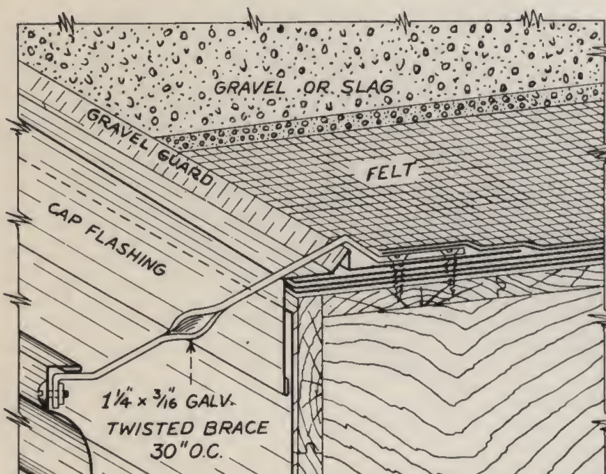


FIG. 3 HANGING GUTTER WITH COMBINATION CAP FLASHING AND GRAVEL GUARD CONNECTING TO COMPOSITION ROOF

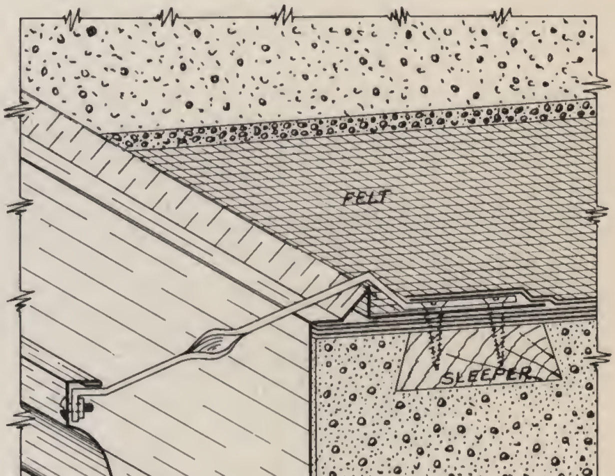


FIG. 4 ANOTHER TYPE OF HANGING GUTTER WITHOUT CAP FLASHING CONNECTING TO COMPOSITION ROOF ON CONCRETE CONSTRUCTION

—NOTE— SCALE 2" = 1'-0"

DRAWING NUMBER 11 — EAVES GUTTERS AT FLAT ROOFS

caulking into the cast iron drain pipe.

Fig. 2 shows the eaves gutter with cap flashing. The front edge of the gutter is at least 1½ in. lower than the top of the upturned flange at the back to prevent overflow. The gutter is applied as in Fig. 1. The cap flashing laps over the back of the gutter not less than 2 in., is edged at the top and cleated to the sheathing and the roof is put on in the usual manner.

A hanging gutter connection to composition roof is shown in Fig. 3. After the under courses of felt have been laid, the combination gravel guard and cap flashing is nailed through the felt.

Band iron gutter hangers are formed to the shape of the gutter, the front bent only up to the bottom of the ogee mold. These hangers are nailed to the facia with proper pitch to the outlets. Band iron braces attached to the top of the gutter are the same as those shown in Fig. 1 and 2.

Over the bracing and flashing the roofing is laid, properly cemented with hot pitch and the gravel or slag is applied in the usual manner.

Fig. 4 shows a gutter with gravel guard attached. This requires no cap flashing or gutter hangers. The proper pitch to the outlets is provided when the gutter is formed. Braces are the same as those shown in Fig. 1, 2 and 3.

Hanging Gutters with Expansion Joint

Drawing No. 12

The hanging gutters shown in Drawing No. 12 are set in wrought iron hangers, with and without expansion joints. This drawing also shows the connections to gooseneck and conductor head, the constructions presented being applicable to all kinds of roofing.

Fig. 1 is the detail of a hanging gutter which permits of the use of expansion joints. This gutter is not secured to the roof and is therefore free to expand and contract. For a galvanized iron gutter, 1½ x ¼-in. galvanized band iron hangers are to be used; for copper gutters, brass hangers are used. The top of the hanger is countersunk in the sheathing, as shown at *A*, and secured with two large flat head wood screws. These are of steel if galvanized band is used or of brass if bands are brass. The hangers are spaced 30 in. on centers, and have a projecting angle at the outer edge as shown at *B*, over which the gutter is hooked. The projecting ¾-in. edge at the back of the gutter is secured to the roof by cleats as shown.

A gutter without expansion joint is presented in Fig. 2. The band iron hangers are attached to the roof the same as Fig. 1. The gutter is formed with a lap extending up to the roof with the edge turned at the top. The brace is attached to the hanger with bolts as shown at *B* and nailed to the roof, capped and soldered at *C*. The brace is twisted as shown at *D* to prevent water flowing over the edge of the gutter. The connection to the conductor head is shown in Fig. 1.

The construction of the expansion joint is given in Fig. 3. It is important that the distance is sufficient to allow for the difference in temperature so that expansion and contraction are unhampered by crowding, but not too great so as to be larger than required.

Eaves Gutters for Various Roofs

Drawing No. 13

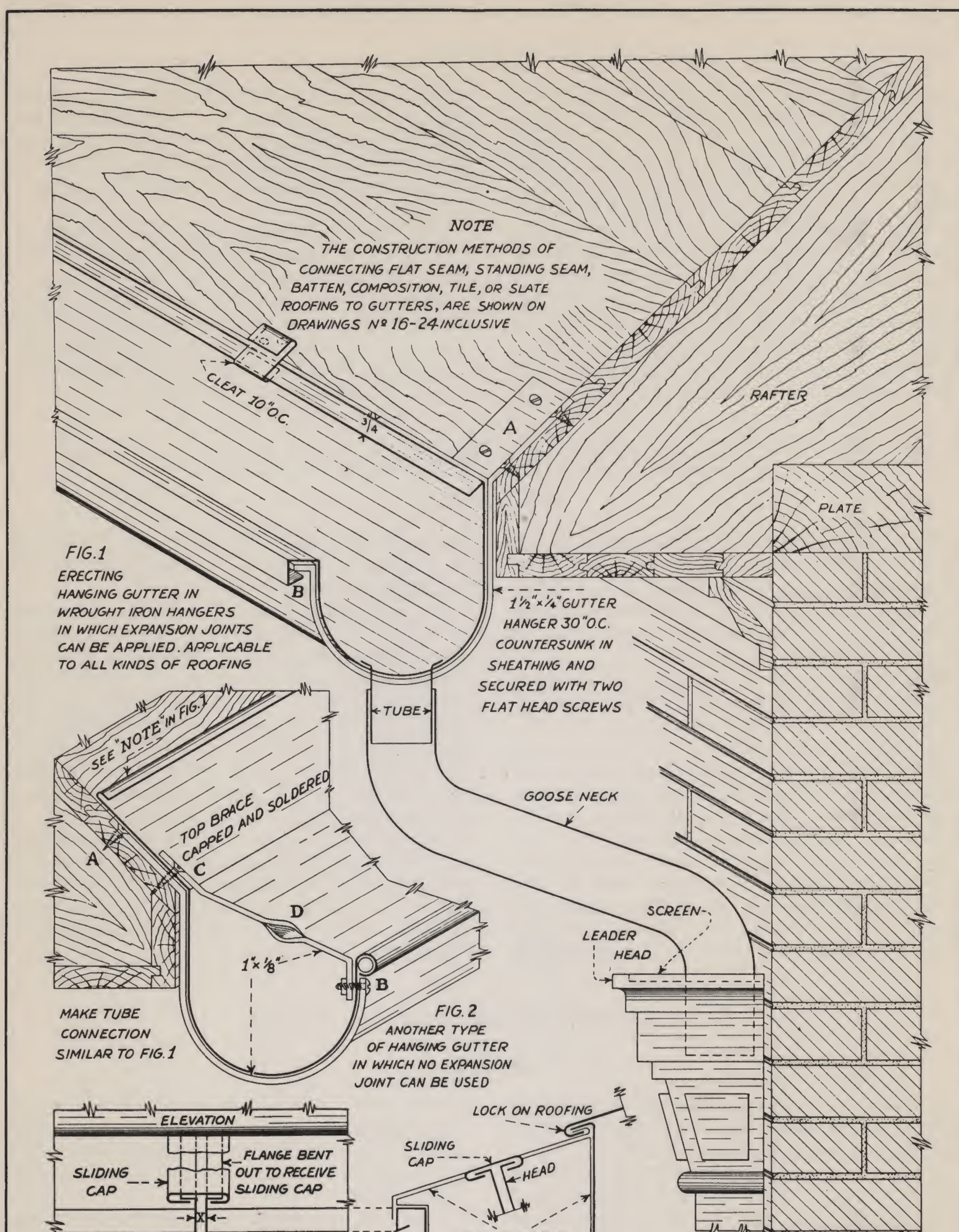
In Drawing No. 13 are presented four types of hanging gutters connecting to flat seam, standing seam, batten and composition roofing.

A half round gutter with single bead reinforced with ⅜-in. rod is shown in Fig. 1. Here the roof flange is part of the gutter with the edge turned up at the top, for securing to the sheathing with cleats. The gutter brace is formed to clasp the bead and secured to sheathing with barbed roofing nails. The brace is capped and soldered to prevent leakage.

The gutter shown in Fig. 2 is similar to that presented in Fig. 1, but minus the reinforced rod in the bead. The roof flange and gravel guard are attached to the top, as shown. The braces are secured to the front of the gutter with round head bolts and nailed to the roof sheathing over gravel guard.

Fig. 3 shows a gutter with a molded front. The roof flange is the same as in Fig. 1. The brace is riveted to the front flange of the gutter at *A* and to the back of the gutter as at *B*. This rivet is protected by solder.

A hanging gutter with cap flashing is shown in Fig. 4. Wood molding is nailed to the facia as shown on the bottom of the gutter for it to rest



DRAWING NUMBER 12 — HANGING GUTTERS WITH EXPANSION JOINT

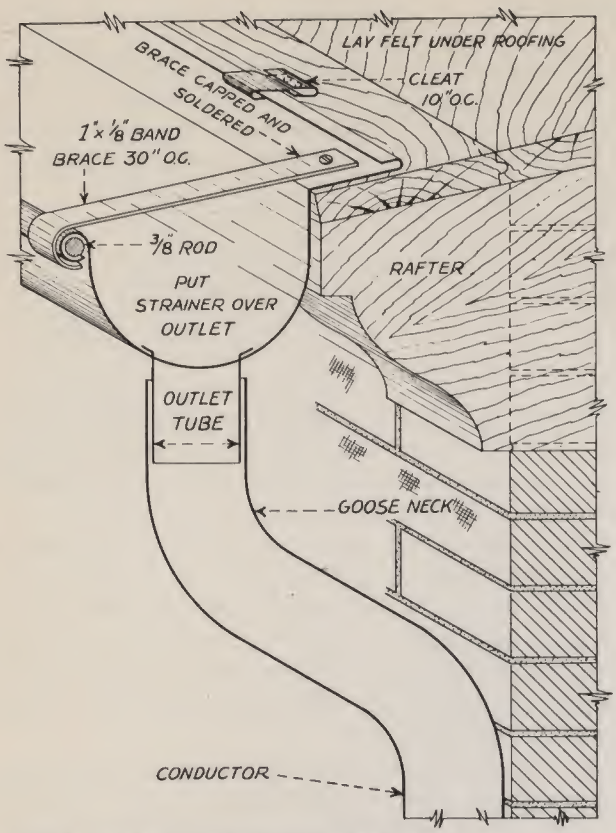


FIG. 1 HANGING GUTTER WHICH CAN BE USED IN CONNECTION WITH FLAT SEAM, STANDING SEAM AND BATTEN ROOFING Scale 2"=1'-0"

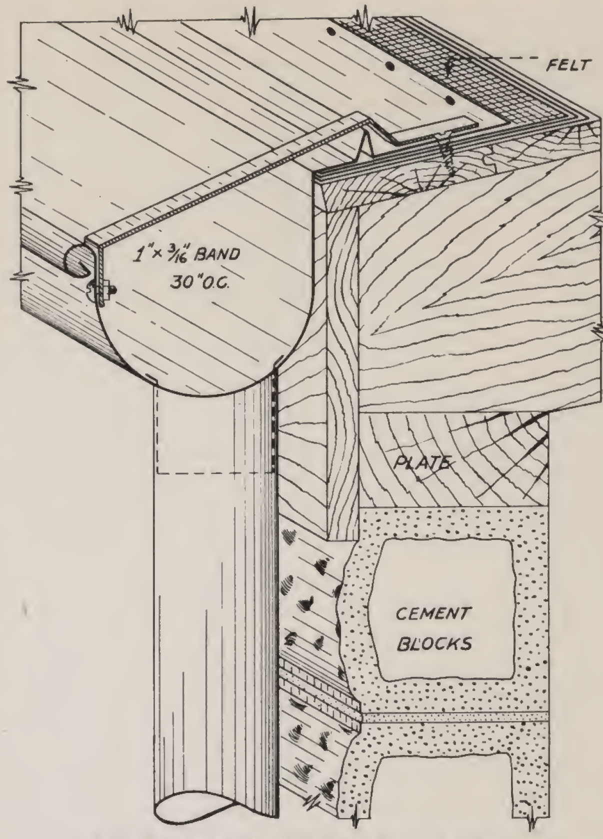


FIG. 2 HANGING GUTTER FOR GRAVEL, SLAG AND FLAT TILE ROOF INSTALLATION
Scale 2"=1'-0"

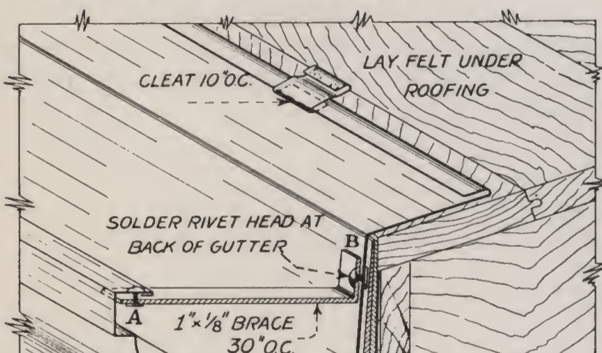


FIG. 3 ANOTHER TYPE OF HANGING GUTTER FOR FLAT SEAM, STANDING SEAM AND BATTEN ROOF INSTALLATION
Scale 2"=1'-0"

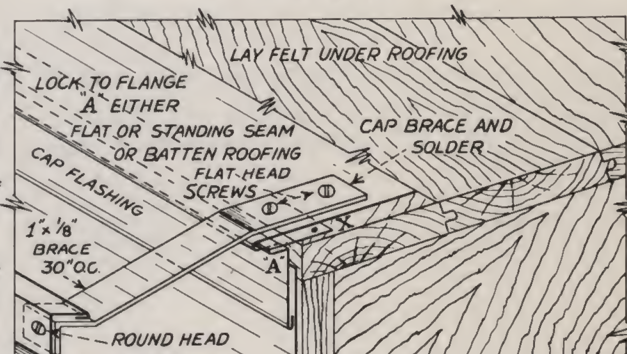


FIG. 4 HANGING GUTTER WITH CAP FLASHING, FOR FLAT SEAM, STANDING SEAM AND BATTEN ROOF INSTALLATION Scale 2"=1'-0"

NOTE } THE CONSTRUCTION METHODS OF CONNECTING FLAT SEAM, STANDING SEAM, BATTEN, TILE, SLATE AND COMPOSITION ROOFING TO GUTTERS ARE SHOWN ON DRAWINGS Nº 16–24

Drawing Number 13 EAVES GUTTERS FOR VARIOUS ROOFS

on. The front edge of the gutter is at least $1\frac{1}{2}$ in. lower than the upturned back. The gutter sets on the wood molding and is nailed to the sheathing at the top. The cap flashing is then applied.

The braces, made of 1 x $\frac{1}{8}$-in. band iron and spaced 30 in. on centers, are attached to the front of the gutter with round head bolts and nailed to the roof sheathing with two barbed roofing nails. These braces are properly capped and soldered.

Eaves Troughs and Hangers for Various Roofs

Drawing No. 14

Four types of eaves troughs and hangers for connection to any kind of roof installation as well as the method for constructing the expansion joint in the eaves trough, are presented in Drawing No. 14.

In Fig. 1 is shown an eaves trough with double bead with hanger for pitched roof construction. The eaves strip is shown at *X*. This eaves trough may be used with either a flat lock or standing seam roof. The hanger is made of $\frac{1}{8}$ x 1-in. band iron. The brace is constructed to accurately surround both gutter beads. The vertical band is riveted to the center of the brace, bent to the proper angle of the roof, allowing for pitch to the outlets. The hanger is nailed to the roof sheathing with two barbed wire roofing nails. If a metal roof is used, then the hanger is capped and soldered.

An eaves trough with a double bead is presented in Fig. 2. The gravel stop and drip is applied to the roof as shown. The hanger is similar to that shown in Fig. 1, except that both the brace and hanger are twisted. This hanger is applied to the gutter the same as in Fig. 1 and also attached to the roof in the same way.

Eaves trough hangers for flat tile roofing are shown in Fig. 3 and 4, which give the single and double bead eaves trough. The hangers are regular commercial wire eaves trough hangers and are applied as shown. These may be used on small gutters requiring only light duty and draining roofs of small area.

Fig. 5 presents the method of constructing the expansion joint in the eaves trough. The upper part of the illustration shows two heads soldered in the ends of the eaves trough, the distance marked *X* being allowed between the heads, to provide for temperature variation. The lower part shows the space between the two heads marked *C* and *D* with expansion and sliding cap covering them.

Eaves Troughs Erected with Adjustable Hangers

Drawing No. 15

Some examples of eaves troughs erected in cast hangers with adjustable shanks for any pitch of roof and for any type of roof installation, are presented in Drawing No. 15.

Fig. 1 shows the adjustable shank driven into the joint of the brick or stone wall. The combined metal eaves strip and drip is nailed to the edge of the sheathing and metal roofing is locked to the projecting edge of the strip as at *A*. This is turned down as shown by *A′* in the diagram below. The turning down of the lock also covers the nail heads. The hangers are attached to the shank with bolts and are graded to allow pitch of the gutter to the outlets.

A roof construction with box cornice is shown in Fig. 2. The shank is screwed to the woodwork, as indicated. The metal eaves strip which covers the projecting beam is nailed at *A* on the bottom and covered with wood molding. It is also nailed at the upper edge of the roof. This type of eaves flashing is applicable to composition or flat tile roofs. Over this flashing the roofing is applied, and the gutters are attached to the hanger the same as shown in Fig. 1.

In Fig. 3 the shank is screwed to the side of the projecting rafter. The eaves strip is formed as shown and nailed to the roof sheathing. Over the projecting flange *A* either standing seam or a flat lock roofing is applied. The edge of the eaves strip is turned down, as the edge *A* acts as a drip. The gutter hangers are again applied as in Fig. 1 and 2.

As shown in Fig. 4, the combination cant and eaves strip is applied as at *B*, and the adjustable shank is nailed to the roof sheathing before the slate is applied, as shown in the broken view, 1, 2 and 3. The gutter hangers are applied in the same way as shown in Fig. 1, 2 and 3.

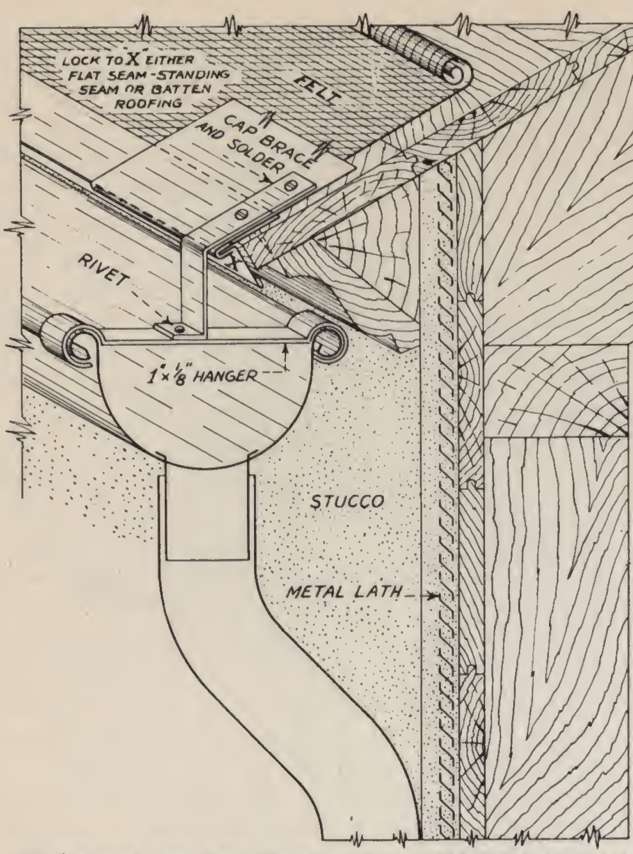


FIG. 1 DOUBLE BEAD EAVE TROUGH WITH HANGER FOR FLAT SEAM, STANDING SEAM AND BATTEN ROOF INSTALLATION
SCALE 2"=1'-0"

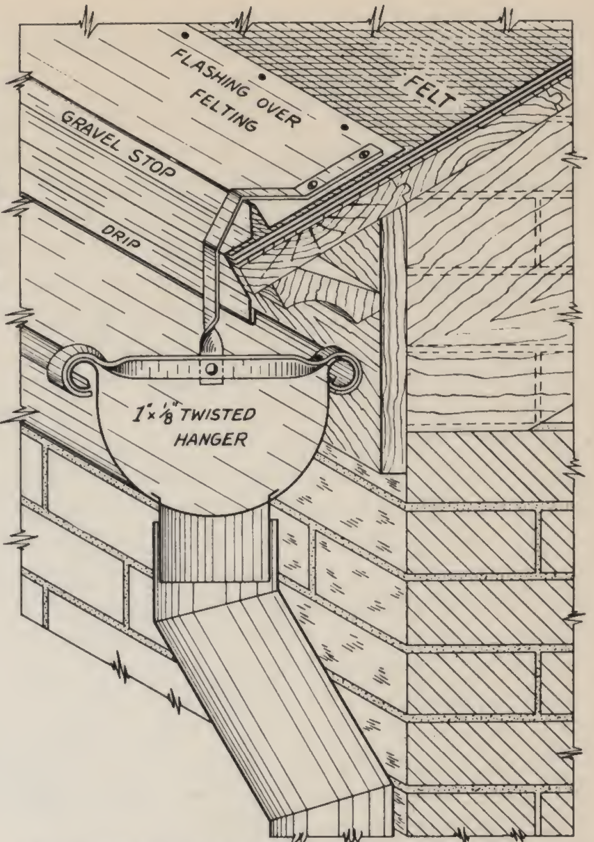


FIG. 2 DOUBLE BEAD EAVE TROUGH WITH TWISTED HANGER FOR COMPOSITION AND FLAT TILE ROOF INSTALLATION
SCALE 2"=1'0"

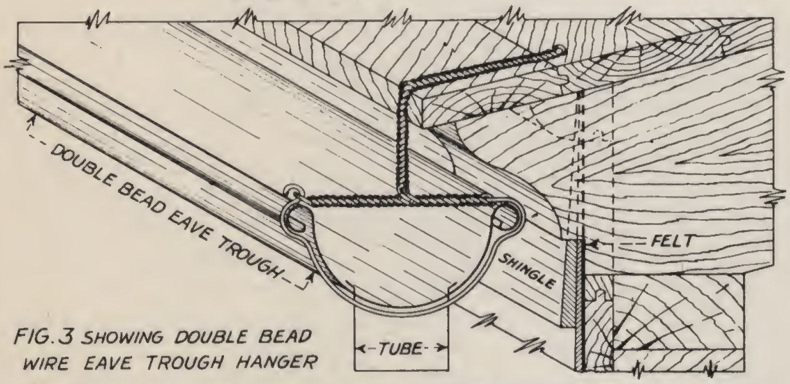
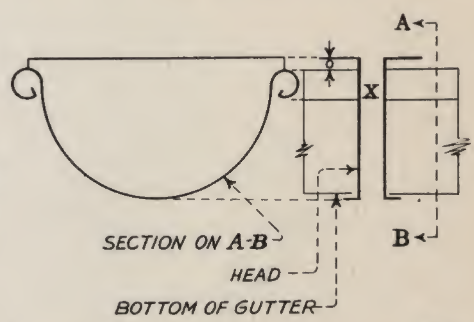


FIG. 3 SHOWING DOUBLE BEAD WIRE EAVE TROUGH HANGER



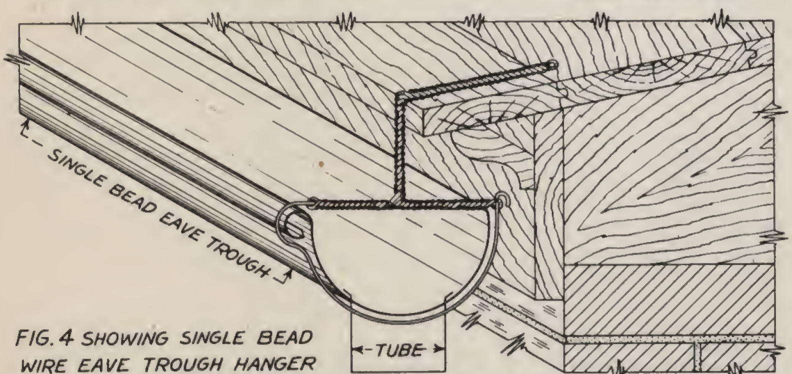


FIG. 4 SHOWING SINGLE BEAD WIRE EAVE TROUGH HANGER

FIG 3 AND 4 SHOW TWO TYPES OF WIRE EAVE TROUGH HANGERS FOR SINGLE AND DOUBLE BEAD TROUGHS, USED ON ROOFS HAVING SMALL AREA FOR ANY KIND OF ROOF INSTALLATION —SCALE 2"=1'-0

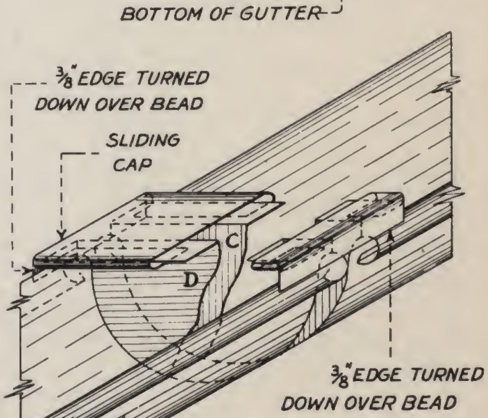


FIG. 5 METHOD OF CONSTRUCTING EXPANSION JOINT IN EAVE TROUGH
—SCALE-2"=1'0"—

NOTE } THE CONSTRUCTION METHODS OF CONNECTING FLAT SEAM, STANDING SEAM, BATTEN, TILE, SLATE AND COMPOSITION ROOFING TO EAVE TROUGHS ARE SHOWN ON DRAWINGS Nº 16 - 24

DRAWING NUMBER 14

EAVES TROUGHS AND HANGERS FOR VARIOUS ROOFS

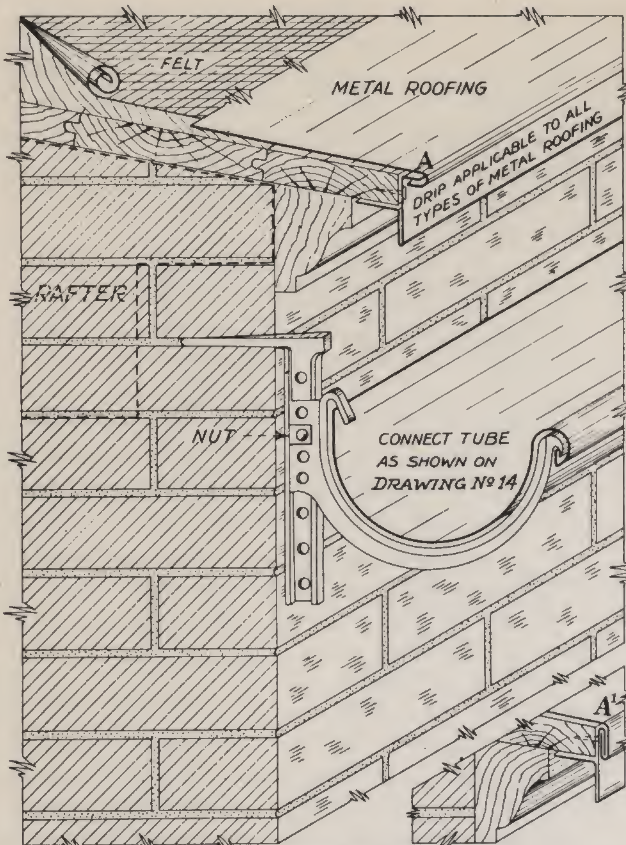


FIG. 1 SINGLE BEAD EAVE TROUGH IN CAST HANGER HAVING ADJUSTABLE SHANK TO DRIVE IN BRICK OR STONE WALL Scale - 2"=1'-0"

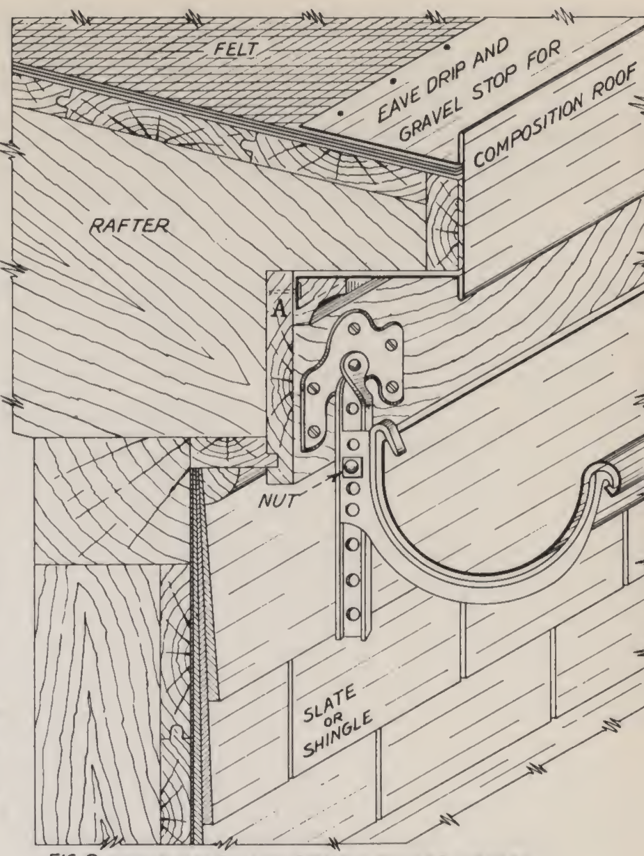


FIG 2 SINGLE BEAD EAVE TROUGH IN CAST HANGER HAVING ADJUSTABLE SHANK TO SCREW AGAINST SQUARE BOX CORNICE — Scale-2"=1'-0"

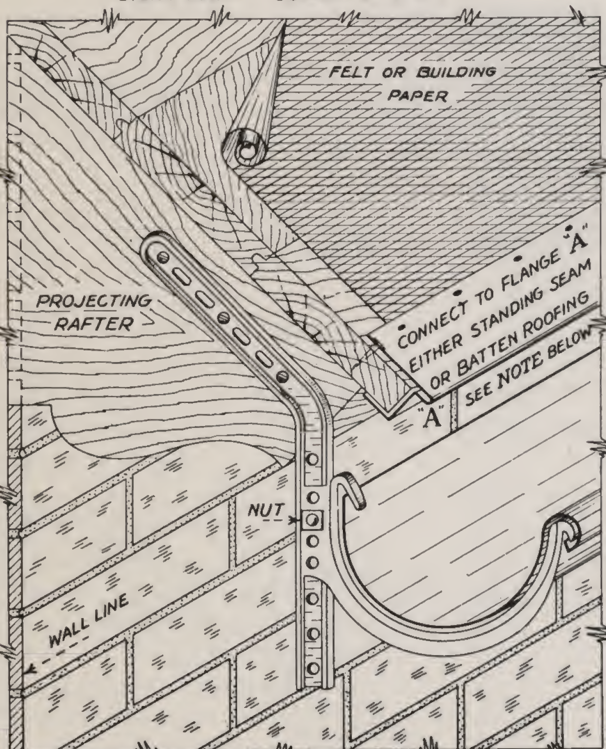


FIG. 3 SINGLE BEAD EAVE TROUGH IN CAST HANGER HAVING ADJUSTABLE SHANK TO SCREW AGAINST EXPOSED RAFTER - Scale - 2"=1'-0" —

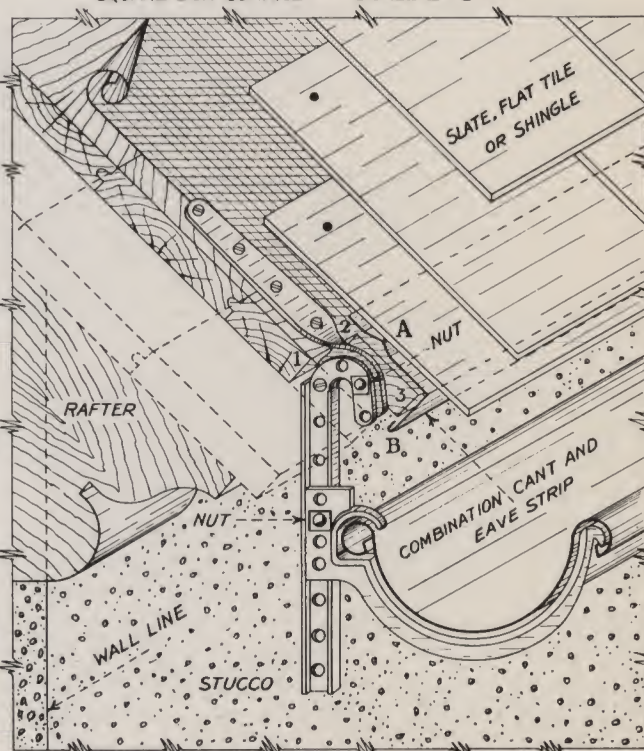


FIG 4 DOUBLE BEAD EAVE TROUGH IN CAST HANGER HAVING ADJUSTABLE SHANK TO SCREW UNDER SLATE, FLAT TILE OR SHINGLE —Scale - 2"=1'-0"—

NOTE } THE CONSTRUCTION METHODS OF CONNECTING FLAT SEAM, STANDING SEAM, BATTEN, TILE, SLATE AND COMPOSITION ROOFING TO EAVE TROUGHS ARE SHOWN ON DRAWING № 16-24

Drawing Number 15

EAVES TROUGHS ERECTED WITH ADJUSTABLE HANGERS

Box Gutter Lining

Drawing No. 16

The details in Drawing No. 16 show the method of lining wood sheathed box gutters with sheet metal and connecting them to sheet metal or wood cornices and flat seam roofing.

Fig. 1 shows how the gutter is formed on sheathing laid inside of a sheet metal cornice. The cornice is constructed with a drip at *A* in the foot mold, with projecting edge at *X* above the crown mold. When the wall is built to the bottom line of the foot mold at *A*, a space of 4 in. (one course of bricks) is left and then the wall carried up as high as *F* to receive the wooden lookouts for the gutter. The wall is then continued and the rafters set. Thus there is an open space of 4 in. from *A* upward. The braces are located on the wall and wall hooks driven in the brick joint as at *B*, with the top of the hook turned inward as at C. The lower anchor on the cornice also has an acute angle as at *D*.

The cornice is set on the wall and the drip drawn snugly against the wall line by twisting the wire as at *E*. The cornice is set plumb and true by temporary fastenings and the anchor *F* bolted to the brace as at *G*. The brick wall is completed in the 4-in. space up to the top of the rafter, which holds the cornice in position.

In sheathing the gutter it is essential that all nails are driven flush and the proper grade given to the outlets. Note that there are no right angular corners in the gutter. The sheet metal gutter lining is locked to the front edge of the metal cornice as shown and turned on the roof with a lock secured with cleats. All cross seams in the gutter are cleated.

As shown at *a* the upper flange of the cornice is nailed in a straight line about 2 or 3 in. apart.

Fig. 2 shows how the gutter lining is connected to the wood cornice to allow for expansion and contraction and to avoid nailing along the front gutter edge, as is frequently done. Two methods are shown. The first one, *A*, consists of a double fold angle nailed to the top of the cornice as at *b* to which the gutter lining is locked. In the other method presented in Fig. 3, a single angle is employed with a hem edge at the bottom as shown, nailed to the front edge of the crown mold as at *C* to which the lining is locked. To cover the nail heads, the lock is turned down as shown at *B* in Fig. 4.

Expansion Joint for Box Gutter Lining

Drawing No. 17

In Drawing No. 17 is shown how the lock is made between flat seam roofing and box gutter lining so that the expansion joints may be constructed at both high and low points of the gutter lining.

Fig. 1 shows the construction of the lock at the eaves line joining the gutter lining. While a flat seam roof is here shown, this lock is used also with standing seam and batten roofing. It is also used in connection with the eaves strip on composition, flat tile, slate and Spanish tile roofs.

The upper part of the metal cornice shown in Fig. 1 has a roof flange as indicated at *A*, which is nailed to the sheathing. Over this flange the gutter lining locks as at *B*. At the eaves of the roof the gutter lining is turned out $\frac{5}{8}$ in. as shown at *C*. The flange *C* is secured every 8 or 10 in. with cleats, as at *D*, over which the roofing sheets are locked as indicated at *E*. Note the small drip bent on the roofing lock at *F*, which prevents capillary attraction.

To allow for the expansion and contraction of the gutter in its length, expansion joints are placed at the high and low points of the gutter. When the head is soldered in, the upper flange extends below the gutter flange a distance equal to *W*. The height at *X* is just enough to permit the locks on both sides of the sliding cap to slip in with ease, which is clearly indicated in Fig. 2 and 3.

In Fig. 2 is shown the connection of the heads and sliding cap at the upper end of the gutter, under the gutter flange at the eaves. Note that the sliding cap has an upturned lock at *A*, which slips under the $\frac{5}{8}$-in. outward turned flange of the gutter lining, as shown at the left and over this gutter flange and lock of the sliding cap, the roofing is locked. Where the roofing fastens over the lock of the sliding cap, the drip shown at *B* is notched out.

Fig. 3 shows clearly the connection of the heads and sliding cap at the lower end of the gutter where it joins the cornice flange. Note the broken view along *B-C-D*. The height of the head at *F* is exaggerated. It should be high enough to allow the lock *D* to slip in with ease.

To prevent the rain water from following the

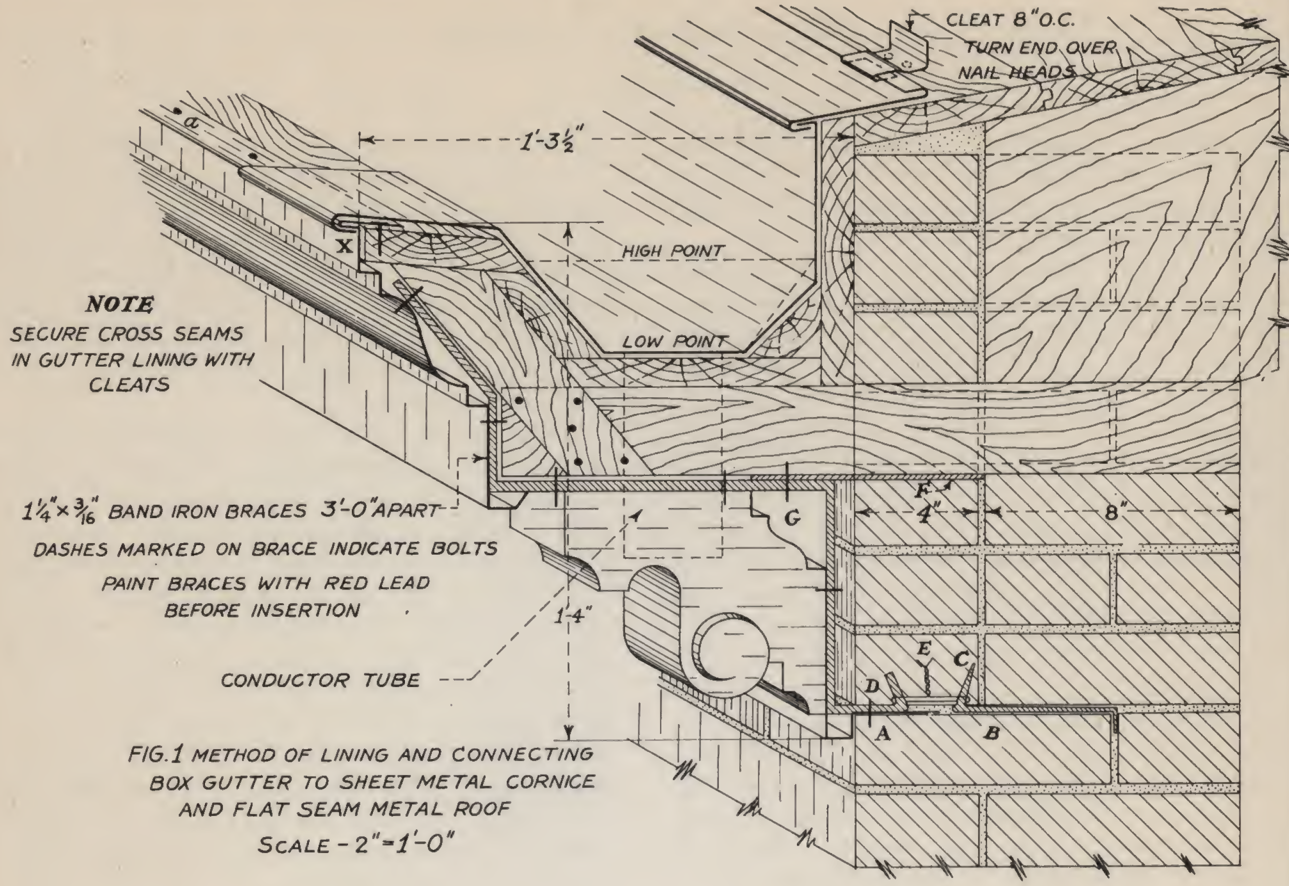
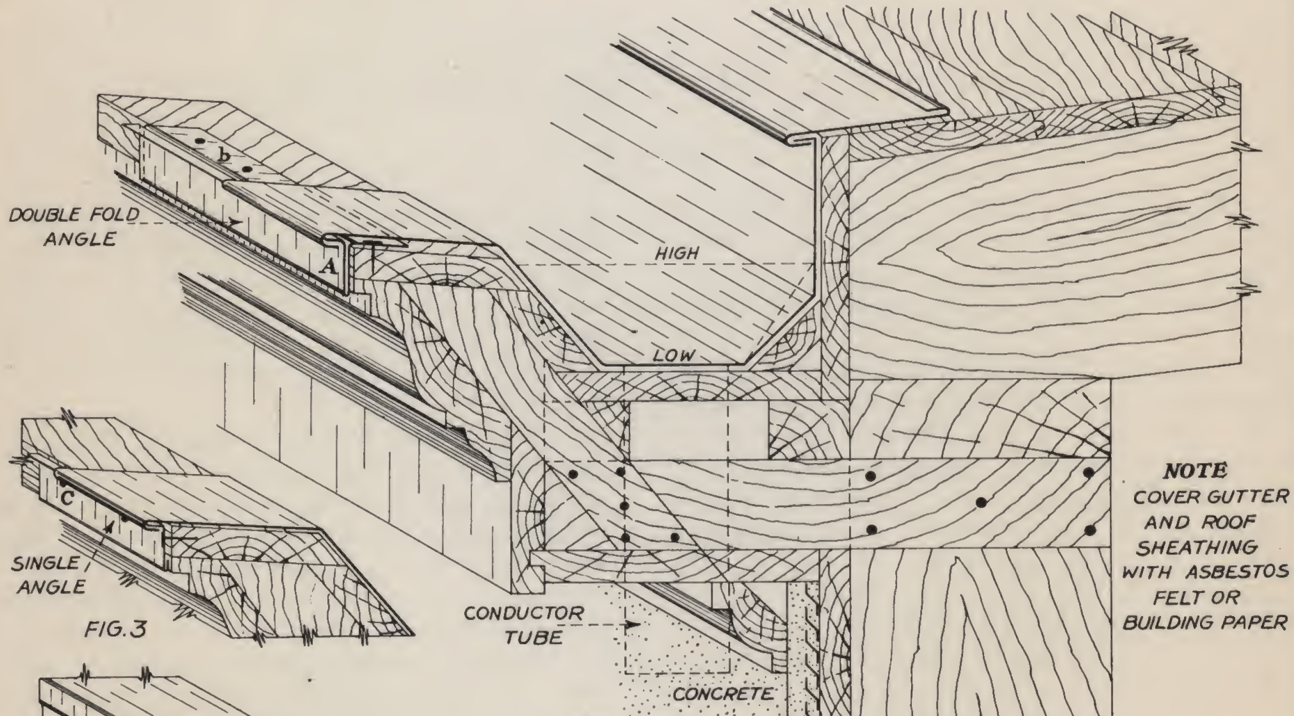


FIG. 1 METHOD OF LINING AND CONNECTING BOX GUTTER TO SHEET METAL CORNICE AND FLAT SEAM METAL ROOF

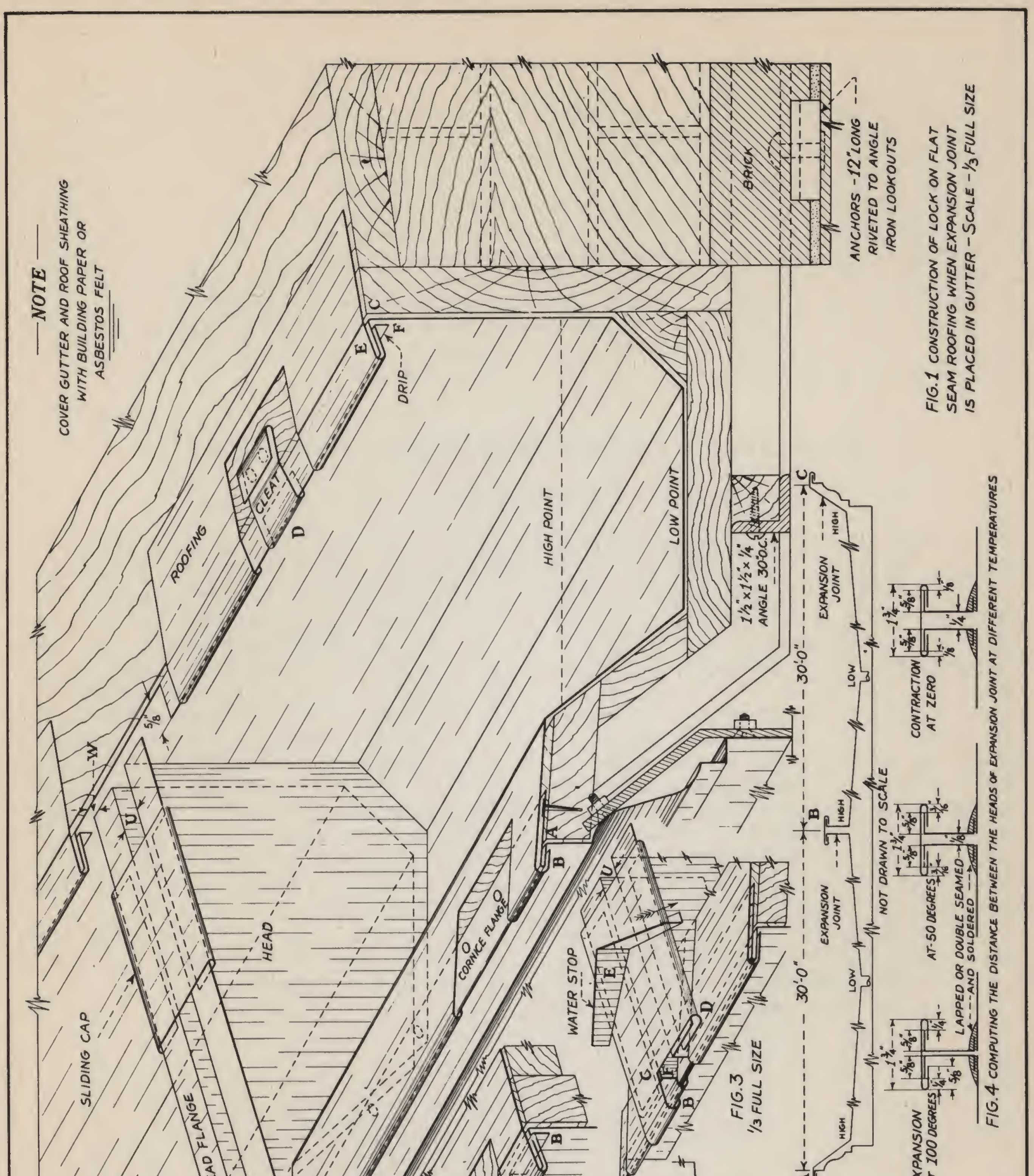
SCALE - 2" = 1'-0"



SCALE - 2" = 1'-0" FOR FIG. 2-3 AND 4

FIG. 2 METHOD OF LINING AND CONNECTING BOX GUTTER TO WOOD CORNICE AND FLAT SEAM METAL ROOF

DRAWING NUMBER 16 BOX GUTTER LINING



DRAWING NUMBER 17 EXPANSION JOINT FOR BOX GUTTER LINING

sliding cap and dripping over the edge of the cornice, a water stop *E* is placed at the lower end, which sheds the water on each side into the gutter, as indicated by the arrow.

Assuming that the gutter is 60 ft. long and there are two leaders or conductors, as shown in Fig. 4, and that copper is used for the lining, as the sheet copper expands and contracts approximately 1/8 in. for every 10 ft. in a rise of temperature from Zero to 100 deg., 60 ft. will expand or contract 3/4 in. This is taken care of by three expansion joints, *A*, *B* and *C*, which allow for 1/4 in. each. Note that the distance between the heads, as at *U* in Fig. 1, 2 and 3, is determined by the temperature at the time the work is erected. If each run of the gutter is 30 ft., as shown in Fig. 4, and the space allowed at each expansion joint is 1/4 in., then if the work is being erected at a temperature of 50 deg., the minimum distance required between the heads is 1/8 in., as shown in the lower center diagram.

Fig. 5 shows a 1-in. scale drawing of the outlet tube at the low point of the gutter, connecting to the leader head.

Box Gutter Lining at Standing Seam Roof

Drawing No. 18

The methods of making connections between standing seam roofing, joining the lock on the flange of the gutter lining turned over the roof, locking the roofing to the edge turned on back of the gutter lining and securing to metal eaves strip fastened to the eaves of the roof, are presented in Drawing No. 18.

Fig. 1 shows the construction of a wood cornice over shingled siding. A double fold metal angle is nailed along the top edge of the cornice, as shown, to which the gutter lining is locked. In this construction, the gutter lining is turned over on the roof with a lock edged, as shown, to which the standing seam roofing is locked. If the roof is quite flat and it is necessary to solder the cross seams as well as the seam joining the gutter lining, then no expansion joints are placed in the gutter, because it is firmly secured to the roofing by means of the flange turning over on the roof. If, however, the roof is quite steep and it is not necessary to solder the cross seams, then expansion joints are placed in the gutter similar to the construction explained in connection with Drawing No. 17, except that the upper line of the head runs from *A* to *B* in Fig. 1 on Drawing No. 18, allowing the sliding cap to slip under the lock of the gutter lining at *A*. If the butt of the standing seam is to be turned down, the appearance is like *X*. Cleats are placed along seam of gutter lining about 8 in. apart, as shown at *Y*. When the roof is quite flat and expansion joints are required, then the gutter lining is bent, as shown in Fig. 2, with a 5/8-in. edge turned outward at the top of the gutter lining as at *C*, to which the roofing is locked. The expansion joints are made as shown on Drawing No. 17.

Fig. 3 shows the metal roofing locked to the eaves strip nailed along the eaves of a roof on which no gutter is desired.

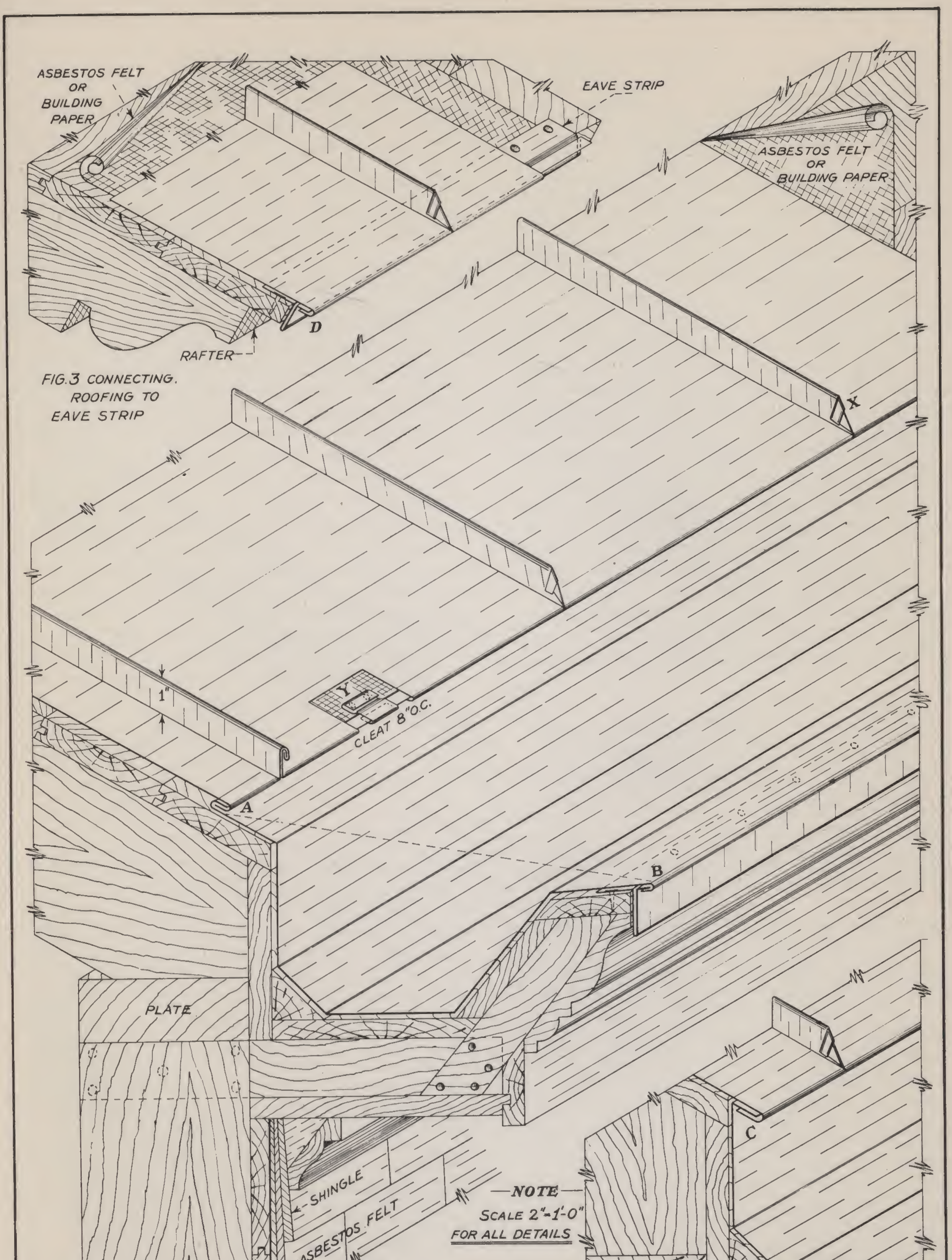


FIG. 3 CONNECTING ROOFING TO EAVE STRIP

FIG. 1 CONNECTING ROOFING TO LOCK ON FLANGE OF GUTTER LINING TURNED OVER ON ROOF

FIG. 2 LOCKING ROOF TO EDGE TURNED ON BACK OF GUTTER LINING

Drawing Number 18

BOX GUTTER LINING AT STANDING SEAM ROOF

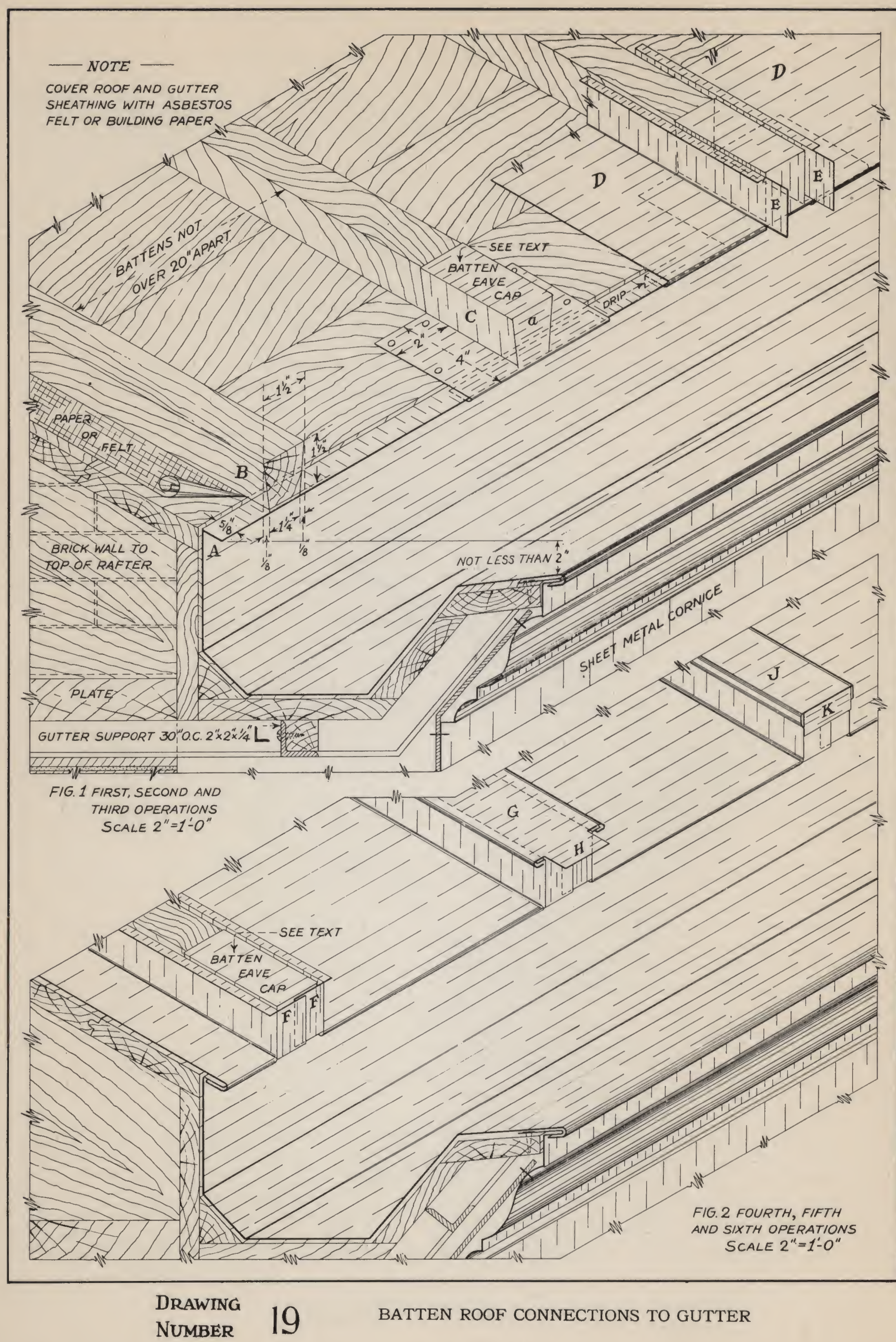


FIG. 1 FIRST, SECOND AND THIRD OPERATIONS
Scale 2"=1'-0"

FIG. 2 FOURTH, FIFTH AND SIXTH OPERATIONS
Scale 2"=1'-0"

Drawing Number 19 BATTEN ROOF CONNECTIONS TO GUTTER

Batten Roof Connections to Gutter

Drawing No. 19

Drawing No. 19 shows how connections are made between the gutter lining and batten roof, providing for horizontal expansion and contraction of the sheets between the battens.

When metal roofing is laid over battens the usual practice is to solder the overlaps shown by *F-F* in Fig. 2. While this is permissible when tin or galvanized iron is used for the covering, as there is practically no expansion and contraction in the 20 or 24-in. space between the battens, this method is not employed when copper or zinc is used. When copper or zinc batten roofing is laid, full allowance is made for the expansion and contraction of the metal both horizontally and vertically. On copper or zinc roof covering, the soldering of the overlaps holds the sheets rigid and firm at the eaves and prevents free movement of the metal sheets between the battens at the eaves line which defeats the very object for which the battens were cut tapered at the base as shown in *B*, Fig. 1, where a 1/8-in. taper is given on both sides of the batten.

To avoid any soldering at the eaves of the batten strip, six progressive steps in the application of the sheet metal are shown in Fig. 1 and 2. Note in Fig. 1 that the back of the gutter is flanged outward as at *A* and the batten strip *B* is placed flush with the outer edge of this flange.

At the lower end of each batten, a batten eaves cap is nailed as shown by *C*. This eaves cap locks to the projecting gutter flange and is made to lap the roof about 2 in. on each side and is 4 in. long. These are formed and the head *a* soldered in at the shop, brought to the job and slipped over the wood battens before the roofing is laid. The roofing sheets *D-D* are laid with cleats 8 to 10 in. apart as previously explained, and the lower ends notched as shown by *E-E*. Note that the locks at the lower ends of the roofing sheets overlap both the lock of the batten cap and the gutter flange. The ends *E-E* are turned over as shown at *F-F* in Fig. 2, *but not soldered.* The cap is then slipped over as shown by *G* and notched at the lower end as at *H*. The double seam is made at the sides of the batten and the edge *H* turned down at *J* and *K*.

Box Gutter Lining at Slate Roofing

Drawing No. 20

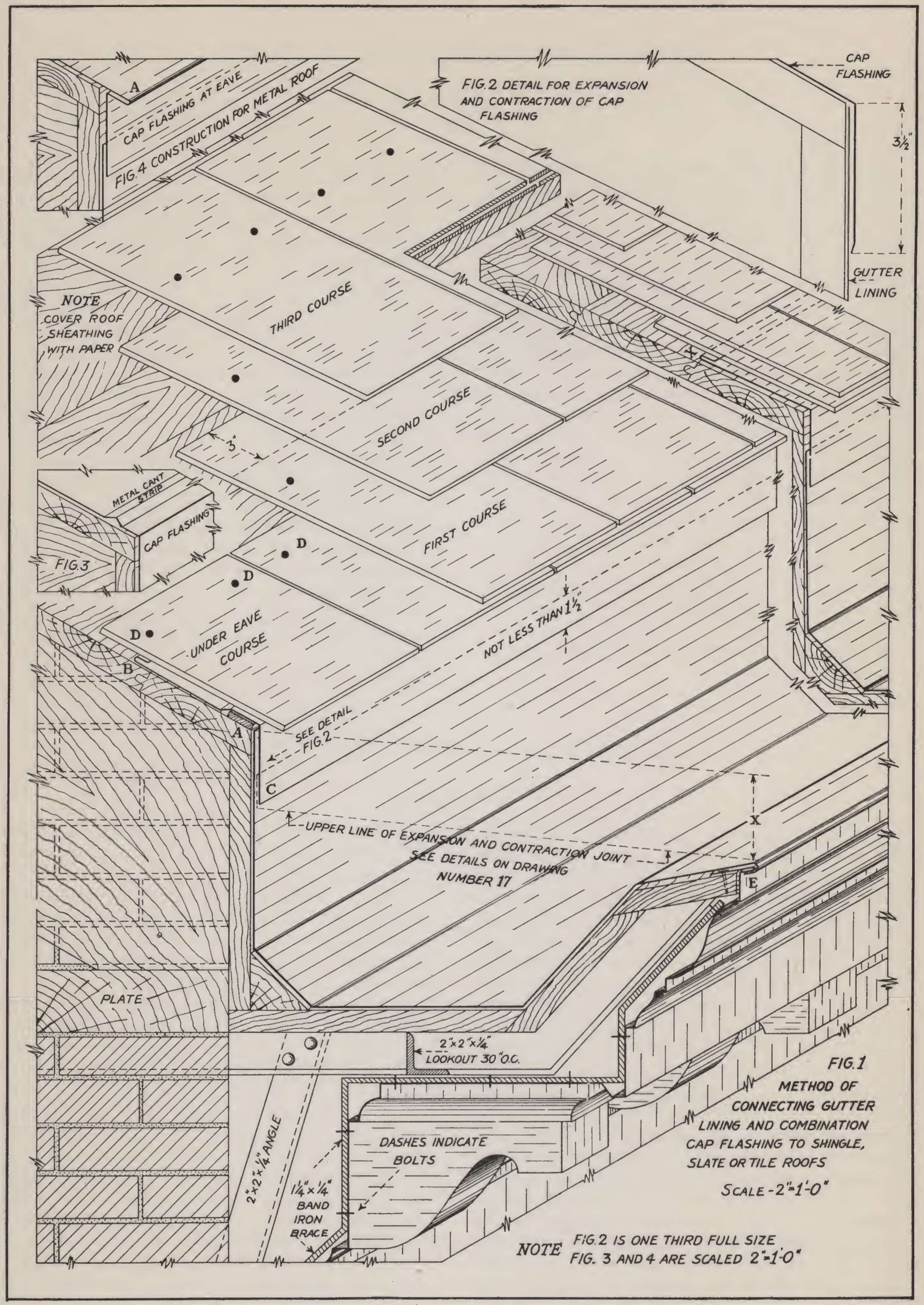
During the process of construction box gutter linings of tin, zinc, copper or galvanized iron, particularly when the roof is covered with slate, tile or sheet metal, are more liable to damage than at any time after the completion of the job. To overcome this hazard, the gutter lining may be laid after the entire roof is completed by following the procedure shown in Drawing No. 20.

After the sheet metal cornice is set and the roof and gutter sheathed, a cant strip indicated by *A* about 1 x 1/4-in. in section is nailed along the eaves of the roof. Over this a roof flange and cap flashing are set, flanged on the roof not less than 6 in. with a lock edge turned at *B*, which is secured to the roof by means of 1 in. wide cleats placed 10 in. apart and the cap flashing turned into the box gutter not less than 3½ in., as shown at *C*. After the cap flashing is secured with cleats hooked into the lock *B* in Fig. 1, the roof is covered with approved felt. The under eaves course of slate is laid to project about 1 in. over the eaves line, care being taken to have the slate nail *D* above the lock *B*. If desired, the cant strip is formed in the sheet metal cap flashing as shown in Fig. 3.

Another method is to omit the cant strip entirely and start with the under eaves course of slate, closing down the lock *X* after it is cleated. The lining slips under the cap flashing at *C*, not less than 1½ in. as shown in Fig. 2.

In constructing the gutter in Fig. 1, the upper point of the back of the lining is not less than 2 in. higher than the lock of the gutter with the cornice at *E*, as shown at *X*, so that in case of overflow, the water will run over the front at *E*, before it runs behind the lining at *A*. If expansion joints are required, the upper line of the expansion cap extends under the lower line of the cap flashing at *C* and is flanged up behind the cap flashing as shown by the dotted line. The construction of the expansion joint is similar to that shown on Drawing No. 17.

Fig. 4 shows the construction of the cap flashing for a metal roof.



DRAWING NUMBER 20 BOX GUTTER LINING AT SLATE ROOFING

Gutter Linings and Flashings at Composition Roofing

Drawing No. 21

In Fig. 1 is shown a combination gravel stop and cap flashing. The main cornice in this case is of metal to which the gutter lining locks at *A* and turns up at the back as far as *B*. After the three-ply felt has been laid, the combination gravel stop and cap flashing shown at *C* is nailed to the roof as indicated and over this the two-ply felt is cemented with hot pitch or asphalt and the slag or gravel applied. If expansion joints are required in the gutter, the upper line of the sliding cap is placed as indicated by the dotted line *D-E*, locking the low end of the cap over the lock at *A* and flashing up at the high end between the gutter lining *B* and cap flashing *D*, as shown on Drawing No. 17.

The outer edges of the gutter at *A* are at least 2 in. below the upper edges of the back of the gutter lining at *B*, so that in case of an overflow the water runs over the front edge of the gutter and not behind the gutter lining at *B*.

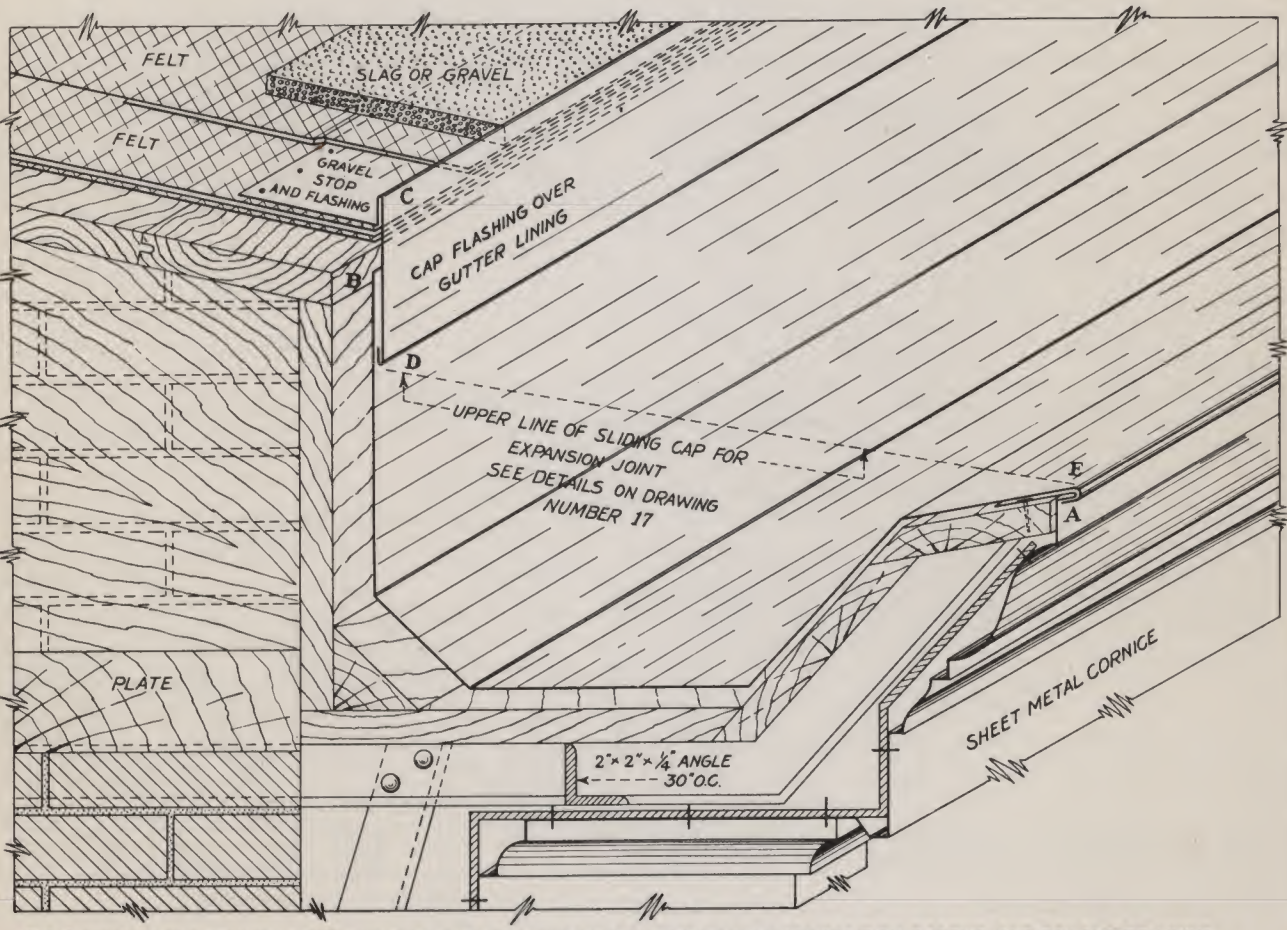


FIG.1 COMBINATION GRAVEL STOP AND CAP FLASHING USED IN CONNECTION WITH COMPOSITION ROOFING AND BOX GUTTER LINING
SCALE - 2" = 1'-0"

DRAWING NUMBER 21 — GUTTER LININGS AND FLASHINGS AT COMPOSITION ROOFING

Flashing Used at Tile Deck Roofing

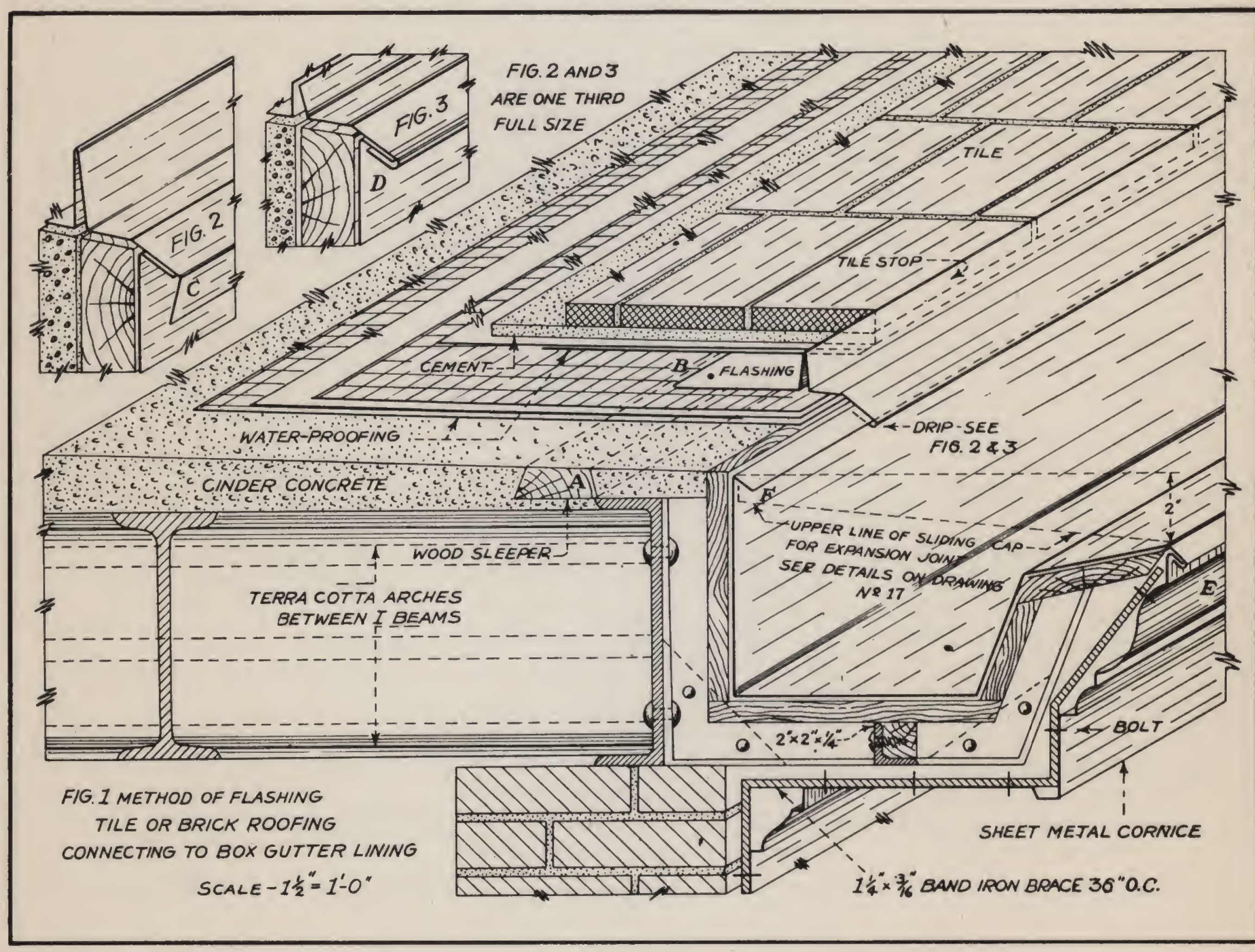
Drawing No. 24

In Drawing No. 24 is shown how flashings are applied when used in connection with tile roofing on flat roofs.

Fig. 1 shows the method of flashing tile roofs connecting to a box gutter lining. If the cornice illustrated is made of galvanized iron and the gutter lining is of copper, great care is required to heavily tin both sides of the lock *E* to the gutter lining before locking to the edge of the crown molding. In this case the tile roofing is laid on a concrete base.

Over the terra cotta arches, which are placed between the I-beams, cinder concrete is graded to the gutter after the wood sleeper *A* has been placed in its proper position to receive the nailing of the flashing. Then the combination flashing, tile stop and drip is nailed in position as shown at *B*, the outer edge of the drip bent as shown at *C* in Fig. 2, which allows the gutter lining to be laid after the roof is completed.

In lining box gutters, the cornice is locked at *E*, as above described, and a ¾-in. flange turned out as shown at *F*. This flange *F* is slipped under the edge *C* in Fig. 2 and then closed with roofing tongs in the position indicated by *D* in Fig. 3. All cross seams in the gutter lining are locked, cleated and thoroughly soldered.



DRAWING NUMBER 24

FLASHING USED AT TILE DECK ROOFING

Gutter Linings on Stone Cornice

Drawing No. 27

Drawing No. 27 illustrates the methods of procedure when a gutter is formed in a stone cornice and when the gutter is built up on top of the cornice.

The details for lining a gutter in a stone cornice are presented in Fig. 1. In this case the stone is cut out to receive the lining, the proper pitch to the outlet carefully graded with concrete. At the front edge of the cornice a reglet is cut about 1 in. deep and ½ in. wide, dovetail in shape, into which a standing strip is placed, the reglet filled with molten lead and then caulked. This strip is provided for the purpose of allowing the gutter lining to be locked to the front edge, as shown in Fig. 2.

After the gutter is lined, as shown in Fig. 1, a cap flashing is placed over it and flanged in the reglet cut in the stone facing not less than 1½ in. and secured with lead plugs about 1 in. wide, spaced about 10 in. apart. The space between the plugs is filled with roofers' elastic cement to match the color of the stone or brick work. The construction of the lining is such that the lower edge of the cap flashing is not less than 2 in. above the front edge of the gutter.

If the gutter outlet is connected to an inside drain, a lead gooseneck is used as shown in Fig. 1, and a brass ferrule soldered to same to allow it to be caulked into the iron drain by the plumber. The lead gooseneck is flanged and soldered to the lining, as indicated in the illustration.

Fig. 3 shows the methods of building a gutter on top of a stone cornice. A reglet is cut in the cornice into which the flange of the top mold is placed and caulked as already explained. Back of this metal mold is blocking and wood sheathing, secured to wood furring, which in turn is secured to the stone cornice with expansion bolts.

The gutter lining is locked to the front flange of the sheet metal mold and a ¾-in. flange is turned out on the back of the gutter, as shown. To this ¾-in. flange either flat seam, standing seam, batten, composition, tile or slate roofing may be connected by following the details of construction shown on Drawings No. 16 to 24, inclusive.

Gutter Linings in Concrete and Terra Cotta Cornices

Drawing No. 28

The procedure for lining box gutters formed in concrete and terra cotta cornices is illustrated in Drawing No. 28.

Fig. 1 shows a cornice of concrete construction with a reglet *A* molded in the concrete about 1 in. wide and 1½ in. deep. This concrete gutter is made flaring at the sides to avoid broken seams when ice forms in gutter. Sleepers are placed in the concrete roof about 24 in. apart on which the sheathing is nailed.

In lining the gutter, a standing strip is placed in the reglet, projecting over the top of the concrete not less than 1 in. The reglet is filled with molten sulphur and as the sulphur expands when it cools, a tight joint is obtained. The gutter lining is locked to the strip at *B* as shown and turns out at the eaves line of the roof with a ¾-in. edge to which either type of roofing is locked as shown on Drawings No. 16 to 24, inclusive.

When copper is used for gutter lining, the sheets at all cross joints are tinned 1½ in. on both sides before the locks are turned. The locks are cleated and well soldered. Strainers are placed over all openings to avoid stoppage of inside drains. If expansion joints are required, the construction shown in details on Drawing No. 17 are applicable.

Fig. 2 shows the construction details of gutter lining in a terra cotta cornice with flashing to a parapet wall. A cap flashing is built in the wall as the masonry progresses. The flashing enters the wall the width of a brick, as shown, and turns up about 1 or 2 in. as indicated by *F* and turns down on the outside not less than 3 in.

As described in connection with Fig. 1 the standing strip in Fig. 2 is also placed in the reglet and this is filled with molten sulphur. The gutter lining is locked to the strip at *H* and turns up under the cap flashing at *J*.

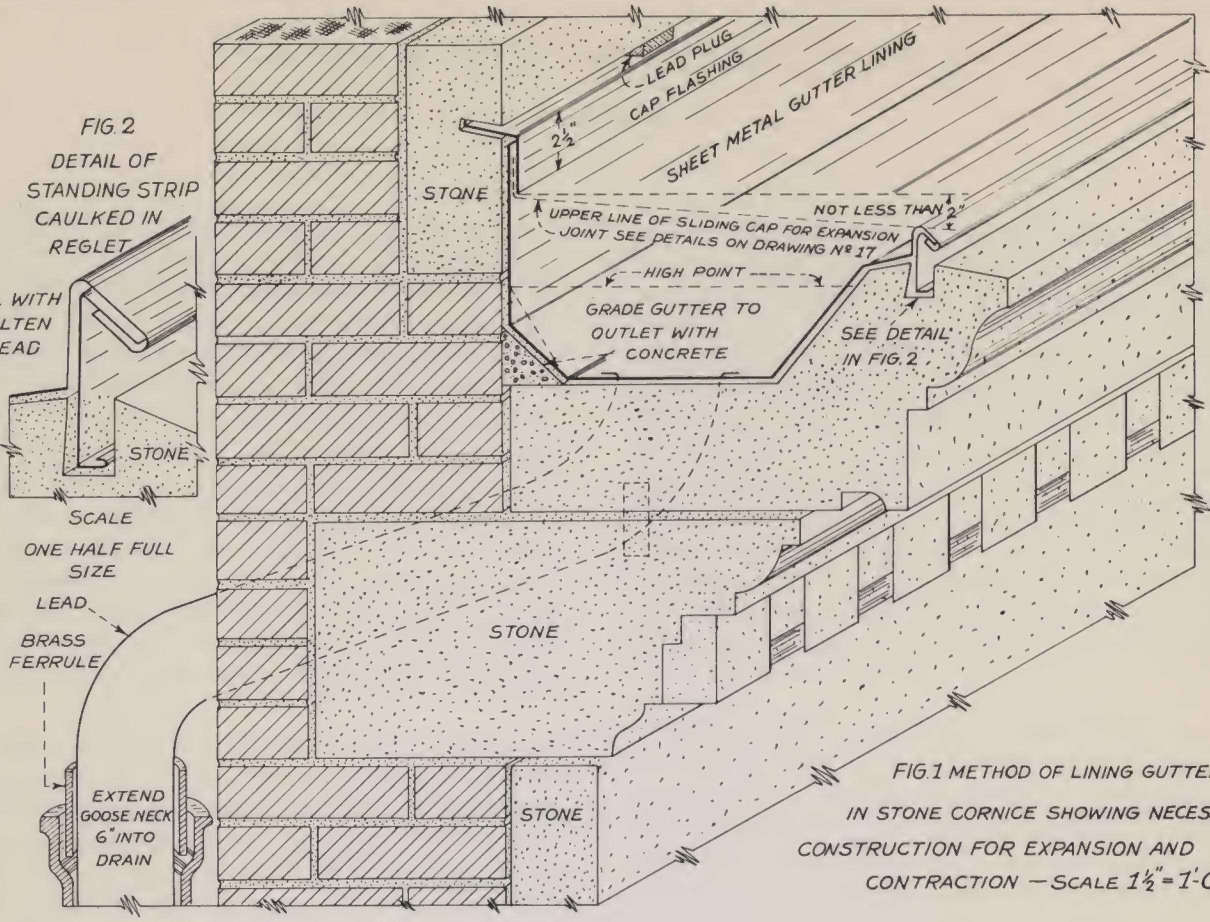


FIG. 1 METHOD OF LINING GUTTER IN STONE CORNICE SHOWING NECESSARY CONSTRUCTION FOR EXPANSION AND CONTRACTION — SCALE 1½" = 1'-0"

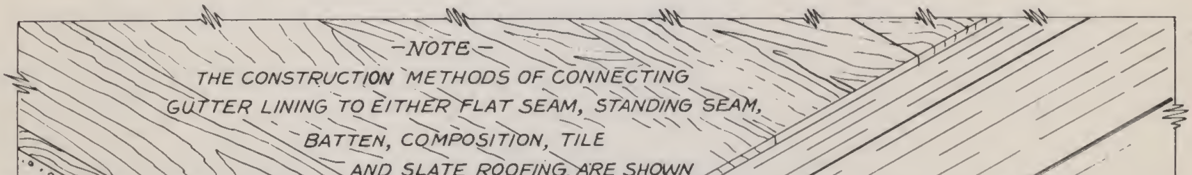


FIG. 3 METHOD OF LINING BOX GUTTER BUILT ON STONE CORNICE — SCALE 1½" = 1'-0"

DRAWING NUMBER 27 GUTTER LININGS ON STONE CORNICE

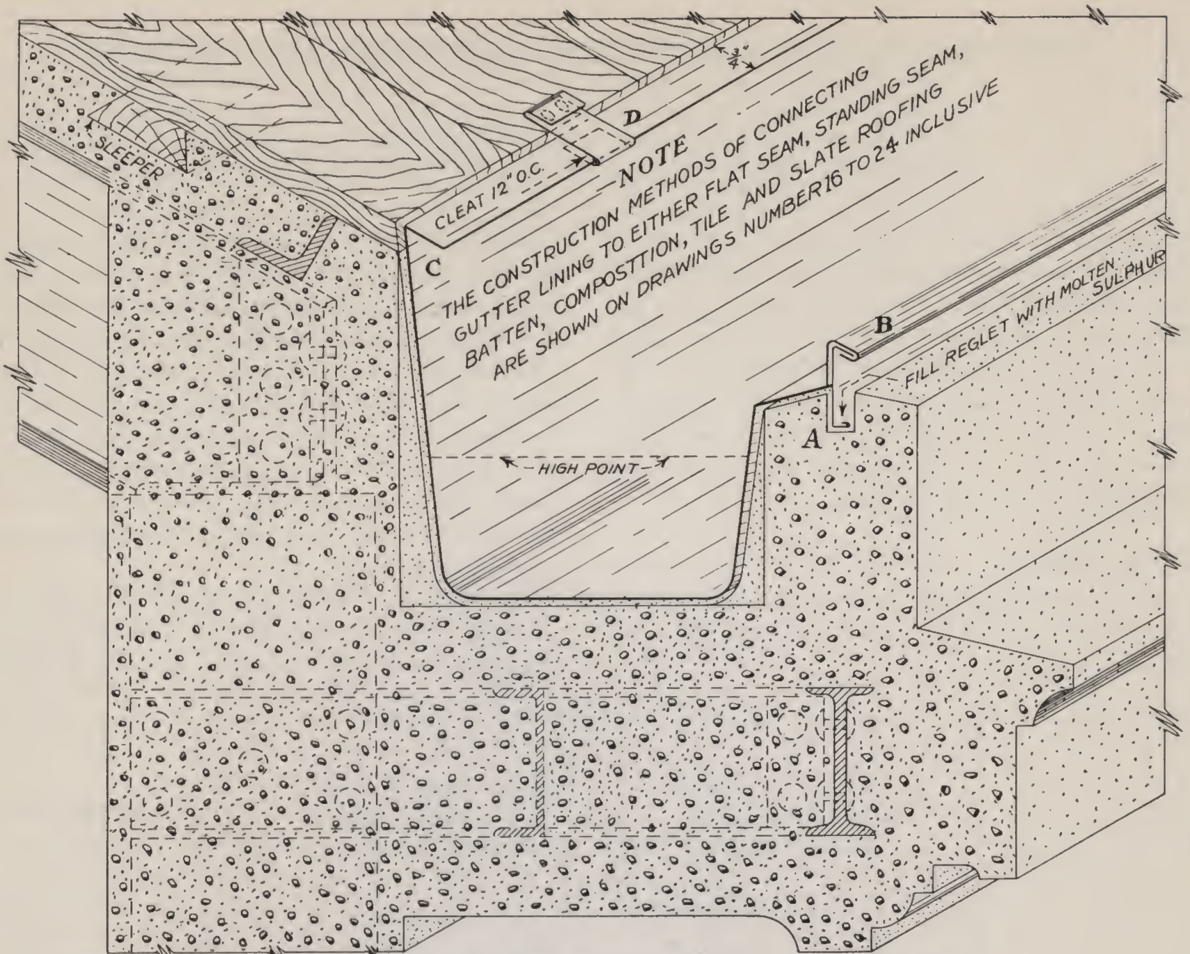
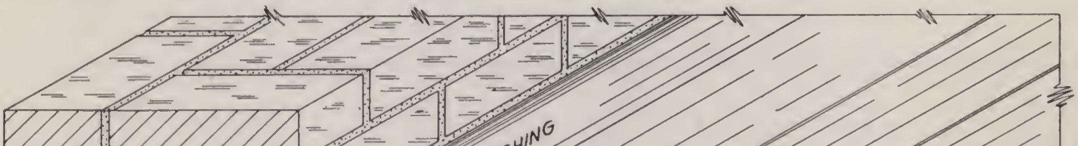


FIG 1 METHOD OF LINING GUTTER IN CONCRETE CONSTRUCTION — SCALE $1\frac{1}{2}" = 1'$-$0"$



— SCALE $1\frac{1}{2}" = 1'$-$0"$ —

FIG. 2 METHOD OF LINING GUTTER IN A TERRA COTTA CORNICE

DRAWING NUMBER 28 GUTTER LININGS IN CONCRETE AND TERRA COTTA CORNICES

PROPORTIONING GUTTERS, LEADERS AND OUTLETS

(This Section reprinted, by permission, from "Modern Applications of Sheet Copper in Building Construction," of Copper & Brass Research Association, New York, N. Y.)

The design of a drainage system as far as capacity is concerned depends on the amount of water to be handled. This in turn depends upon the intensity and duration of rainfall in the particular locality.

The roof area used in computations should be the actual area and not the horizontal projection, or plan, of the area. Rain seldom falls vertically, and the maximum condition exists when it strikes perpendicular to the roof plane, making the total area effective.

RAINFALL DATA

As conditions throughout the country vary rainfall data should apply to the locality in which the structure is to be built.

Fig. 128, below, is a table compiled from charts of the U. S. Department of Labor that show the occurrence and duration of rainfall intensities in 23 cities, for which the U. S. Weather Bureau has included data of excessive rainfalls in its annual reports. In most cases these records begin about 1896, but as few storms were recorded and measured in the early years there may be some discrepancies, particularly for the cities west of the Mississippi River. Where absolute safety is necessary this fact should be borne in mind. These records were used unadjusted in compiling the table.

The type of structure for which the drainage system is being designed must also be considered. A storm of maximum intensity may occur only once in twenty years

	A Storms which should be exceeded only once in 5 years		B Storms which should be exceeded only once in 10 years		C Maximum record Storms	
	Intensity in Ins./Hr. lasting 5 minutes	Sq. Ft. of actual roof drained per Sq. In. of Leader area	Intensity in Ins./Hr. lasting 5 minutes	Sq. Ft. of actual roof drained per Sq. In. of Leader area	Intensity in Ins./Hr. lasting 5 minutes	Sq. Ft. of actual roof drained per Sq. In. of Leader area
Albany, N. Y.	6	200	7	175	7	175
Atlanta, Ga.	7	175	7	175	9	130
Boston, Mass.	5	240	6	200	7	175
Buffalo, N. Y.	5	240	5	240	10	120
Chicago, Ill.	6	200	7	175	7	175
Detroit, Mich.	6	200	6	200	7	175
Duluth, Minn.	5	240	6	200	7	175
Kansas City, Mo.	7	175	8	150	10	120
Knoxville, Tenn.	5	240	6	200	6	200
Louisville, Ky.	6	200	7	175	8	150
Memphis, Tenn.	5	240	6	200	10	120
Montgomery, Ala.	7	175	7	175	7	175
New Orleans, La.	7	175	7	175	8	150
New York City, N. Y.	6	200	8	150	9	130
Norfolk, Va.	6	200	7	175	8	150
Philadelphia, Pa.	6	200	7	175	8	150
Pittsburgh, Pa.	6	200	6	200	7	175
St. Louis, Mo.	6	200	8	150	11	110
St. Paul, Minn.	6	200	6	200	8	150
San Francisco, Cal.	2	600	2	600	3	400
Savannah, Ga.	6	200	7	175	8	150
Seattle, Wash.	2	600	2	600	2	600
Washington, D. C.	6	200	7	175	8	150

Fig. 128—Rainfall Data and Drainage Factors

in a certain locality, while a lower rainfall intensity will be exceeded only once in ten years. If gutter overflow is a matter of inconvenience only, or if the design can incorporate auxiliary drains to care for the excess, the lower intensity may well be used. In residential construction, for instance, no great harm need result if water spills out of gutters during one storm in five years, and the use of the corresponding intensity of rainfall rather than one that will never be exceeded can effect considerable saving.

On the other hand, the architect who is designing a monumental building—where the construction of built-in gutters with cornices, parapets, etc., is such that an overflow would have most serious consequences—can design only for maximum conditions.

LEADER DESIGN

In the design of leaders, practical considerations apply as well as principles of hydraulics. In a given time more water will drop through a vertical pipe than will flow in a horizontal trough of equal area. Therefore it appears that the leader could well be much smaller than the gutter and still take care of all the water coming to it; moreover, it might seem that the leader could be tapered as the velocity of the falling water increases with the fall.

These inferences would follow if only pure hydraulics were involved, but experience has shown that, due to practical considerations, such as frequent plugging by debris, or collapse because of the vacuum created in long drops when a plugged outlet is suddenly cleaned, the following rules must be followed:

(1)—4″ round, square, or rectangular leaders are the minimum (except for small porches);

(2)—The leader area is constant throughout its length;

(3)—Long leader drops are constructed with leader heads every 40 ft., to admit air and prevent vacuums;

(4)—Maximum spacing of leaders must not exceed 75 feet.

With item (4) in mind, the locations of the leaders are first determined. If possible, they should be placed near the corners of the building so that the gutter water will not have to flow far beyond a sharp turn. Building expansion joints, because they necessarily are located at high points in the gutter, will often govern leader location. Of course, appearance and other architectural considerations will also play a part.

With the locations determined, the areas tributary to each leader should be computed. Actual roof areas should be used, not plan areas. These areas are then divided by the proper factor taken from the table in **Fig. 128** and the required areas in square inches of the leaders are thus determined. Then from the table in **Fig. 129** the right-sized leaders are selected.

Fig. 128 gives the intensity of rainfall that can be expected in 23 cities according to U. S. Weather Bureau records, and the corresponding amounts of roof area that one square inch of leader area will drain during such storms. The latter are based on the assumption that for an intensity of 8″ per hour, one sq. in. of leader will care for 150 sq. ft. of roof. The table is set up on three different bases. Column "A" is for conditions that may be exceeded on the average of once in five years; Column "B" for rainfalls that may be exceeded once in ten years; and Column "C" gives the maximum rainfalls yet recorded. Which column should be used in any given instance is a question of judgment for the designer.

Type	Area in Sq. In.	Nominal Leader Sizes
Plain Round	7.07 12.57 19.63 28.27	3″ 4″ 5″ 6″
Corrugated Round	5.94 11.04 17.72 25.97	3″ 4″ 5″ 6″
Polygon Octagonal	6.36 11.30 17.65 25.40	3″ 4″ 5″ 6″
Square Corrugated	3.80 7.73 11.70 18.75	1¾″ x 2¼″ (2″) 2⅜″ x 3¼″ (3″) 2¾″ x 4¼″ (4″) 3¾″ x 5″ (5″)
Plain Rectangular	3.94 6.00 8.00 12.00 20.00 24.00	1¾″ x 2¼″ 2″ x 3″ 2″ x 4″ 3″ x 4″ 4″ x 5″ 4″ x 6″
S.P.S. Pipe	7.38 12.72 20.00 28.88	3″ 4″ 5″ 6″
Cast Iron Pipe	7.07 12.57 19.64 28.27	3″ 4″ 5″ 6″

Fig. 129. Dimensions of Standard Leaders

Example:

Suppose the problem is to design the leaders for a building in Boston which is to be 120 ft. by 80 ft. with a plain gable roof having a ridge down the center and a slope of

9″ to the foot. Assume further that there will be a leader at each corner and that it seems proper to allow for one overflow in ten years.

Solution:

If the slope is 9″ per ft., the roof area on each side of the ridge is 120′ by 50′, or 6000 sq. ft., and each leader would serve 3000 sq. ft.

From Column "B" of **Fig. 128,** opposite Boston, it is found that 200 sq. ft. is the amount of roof area which 1 sq. in. of leader will serve, and accordingly a leader having an area of 15 sq. ins. is required.

By turning to **Fig. 129,** which lists the areas and dimensions of standard leaders, it is found that 5″ round or octagonal leaders are required, or that either 3¾″ x 5″ square corrugated or 4″ x 5″ plain rectangular leaders could be used.

GUTTER DESIGN

SMALL RESIDENCE WORK

As in the case with leader design, judgment plays a large part in the design of gutters. The type of structure has an important bearing. Where occasional overflow of the gutters is not a serious matter, experience has proven certain arbitrary rules entirely adequate. These are based partly on the size of the leaders, determined as outlined above.

The best type of gutter has its minimum depth equal to half and its maximum depth not exceeding three-quarters of its width. Thus width becomes the deciding factor in proportioning size. There is no reason for a gutter deeper than three-quarters of its width except for ornamental purposes, and for practical reasons it is distinctly desirable to keep the gutter shallow. Assuming that the ratio of depth to width is kept within these limits, the gutter can be referred to by width only.

The size of gutters depends upon:

(1) The number, size, and spacing of the outlets.

The gutter acts as a receiving channel to carry the water to the outlet. The slope of the gutter determines the flow toward the outlets.

(2) The slope of the roof.

A steep roof carries the water to the gutter faster than a flat one does.

(3) The style of gutter used.

Some gutters are not effective for their full depth and width. In proportioning gutters consideration of the available area is essential.

(4) A gutter less than 4″ wide is to be avoided.

In ordinary practice 4″ gutters are seldom used for they are difficult to solder and increase the labor cost. The gutter may be the same size as the leader it serves, but, of course, can not be smaller.

(5) Half-round gutters are economical and properly proportioned.

This type uses a minimum of material and insures a proper ratio of width to depth.

(6) A minimum slope of 1/16 of an inch per foot is required.

Less than this will not provide for proper flow of water in the gutter.

Based on the above, safe rules for determining the size of gutters for ordinary work are:

(1) If spacing of leaders is 20′ or less, use a gutter the same size as the leader, but not less than 4″.

(2) If spacing of leaders is more than 20′, add 1″ to the leader diameter for every 30′ (or fraction) additional spacing on peaked roofs, and add 1″ for every additional 40′ of gutter length for flat roofs.

Examples:

1. A 40′ gutter serves a 4″ leader on a flat roof. The gutter should be 5″.
2. A 75′ gutter serves a 4″ leader on a peaked roof. The gutter width is 6″.
3. A 75′ gutter serves a 4″ leader on a flat roof. The gutter width is 6″.

LARGE AND MONUMENTAL BUILDINGS

Gutter and leader installations in large buildings require liberal design to insure against any possibility of gutter overflow. Design and use requirements of monumental structures are often such that a single overflow will have most serious consequences.

For such designs the following formulae (or the charts based on them) are recommended. These are derived empirically from tests carried out on level gutters at the U. S. Bureau of Standards in Washington. By using them liberal sizes are obtained that are ample for important work. These formulae are:

For **Semicircular Gutters:** $W = 1.3\, Q^{2/5}$

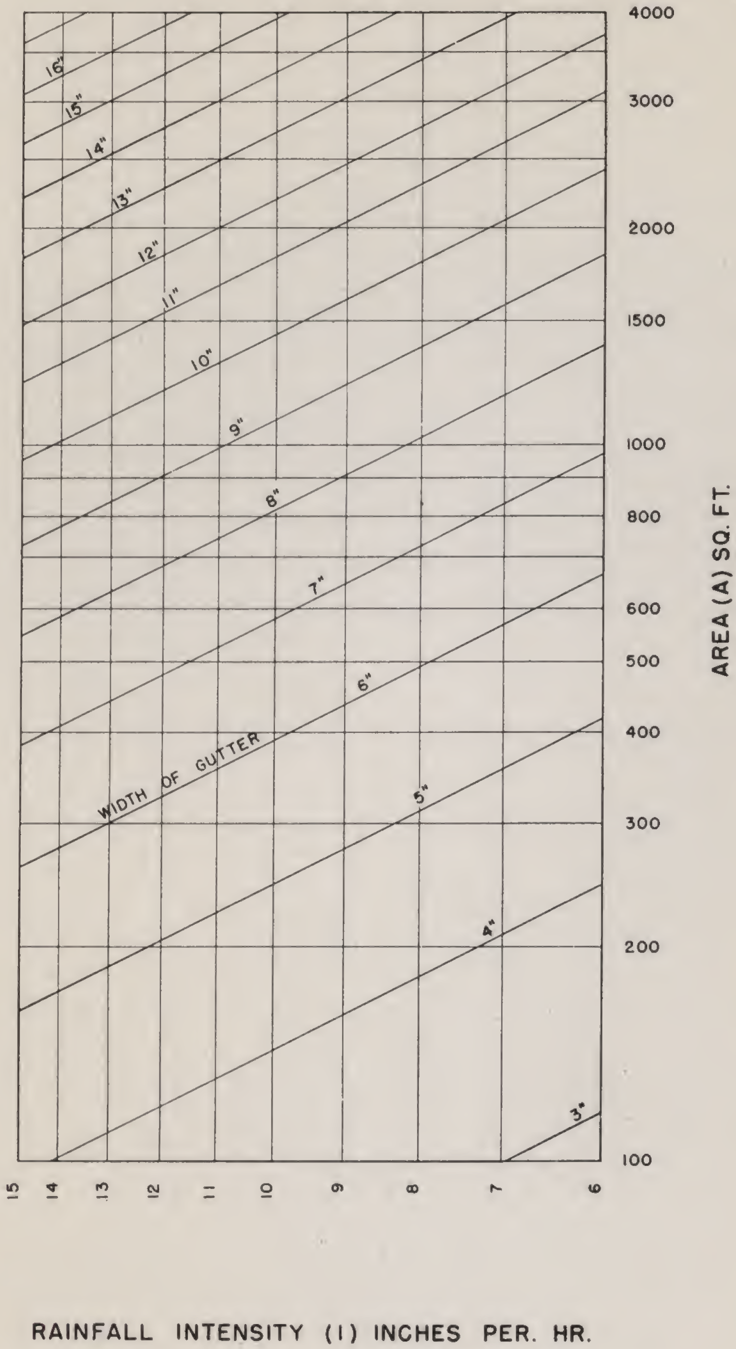
For **Rectangular Gutters:** $W = 0.481\, m^{-4/7}\, l^{3/28}\, Q^{5/14}$

where, W = width of gutter in feet

m = depth/width

l = length of gutter in feet

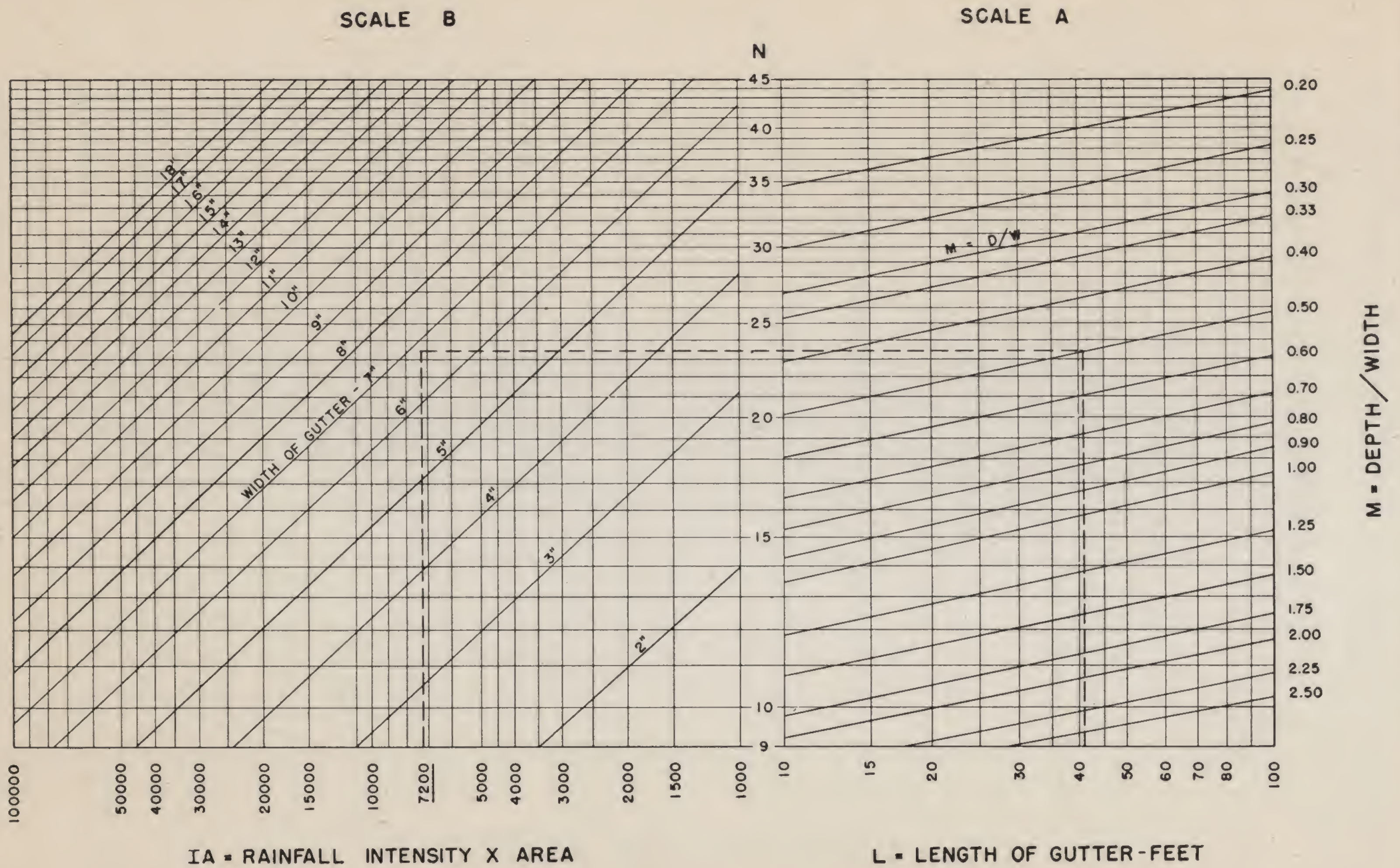
Q = total gutter inflow (cu. ft. sec.)



SEMI CIRCULAR GUTTERS

WIDTH OF GUTTER FOR GIVEN ROOF AREAS AND RAINFALL INTENSITIES

FIG. 130



RECTANGULAR GUTTERS
WIDTH OF GUTTER FOR GIVEN ROOF
AREAS AND RAINFALL INTENSITIES

FIG. 131

The charts on **Figs. 130** and **131** have been plotted from these formulae so that Gutter Widths may be read directly in Inches in terms of Rainfall Intensities and tributary Roof Areas. They are for level gutters. Where the slope exceeds 2% the gutter should be narrowed and deepened to reduce the cavitating action of wave crests that reduces velocities on wide, smooth slopes steeper than 1 on 50.

Example 1: (Semicircular)

A semicircular gutter is required to drain a roof 20′ x 40′, located in Buffalo.

Solution:

In **Fig. 128,** third column, the Maximum Rainfall Intensity, I, of 10″ per hour is given for Buffalo. The roof Area, A, is 800 sq. ft. On the graph of **Fig. 130** find 800 on the bottom scale, pass vertically to the horizontal line representing an I of 10″ per hour. The intersection falls nearly on the line marked 8″ which, accordingly, is the width of the gutter required. If the intersection falls between two sizes, the larger one should, of course, be used.

Example 2: (Rectangular)

A roof area 40′ long by 20′ wide is to be drained by a rectangular level gutter, the depth of the gutter being half of the width. The building is located in Atlanta.

Solution:

From the third column of **Fig. 128** the Maximum Rainfall Intensity, I, for Atlanta is taken at 9″ per hour. From the proportions of the gutter, $m = 0.5$. The length of gutter, is l, is 40′, and the area drained by it, A, is 800 sq. ft. Thence IA = 7,200.

On the chart "Rectangular Gutters," **Fig. 131,** find the vertical line representing $l = 40$. Proceed vertically along this to its intersection with the oblique line representing $m = 0.5$. Thence pass to the left through N = 23.3 (an equalizing Constant) to intersect the vertical line representing IA = 7,200. The point of intersection occurs between the oblique lines representing gutter widths of 6″ and 7″. The required width of gutter is, therefore, 7″ and its depth need be only 3½″.

The required sizes of level gutters of other than semicircular or rectangular shapes can be determined closely by finding the semicircle or rectangle of the same area that most closely fits the irregular cross-section. This is done by drawing the required shape to any convenient scale and making the fit graphically so that the areas of excess and shortage will be equal. A trapezoidal shape of depth equal to one-half the width is closely fitted by a semicircle. A molded gutter can usually be approximated by a rectangle. This method was checked experimentally in laboratory tests, and the discrepancies found to be very small.

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